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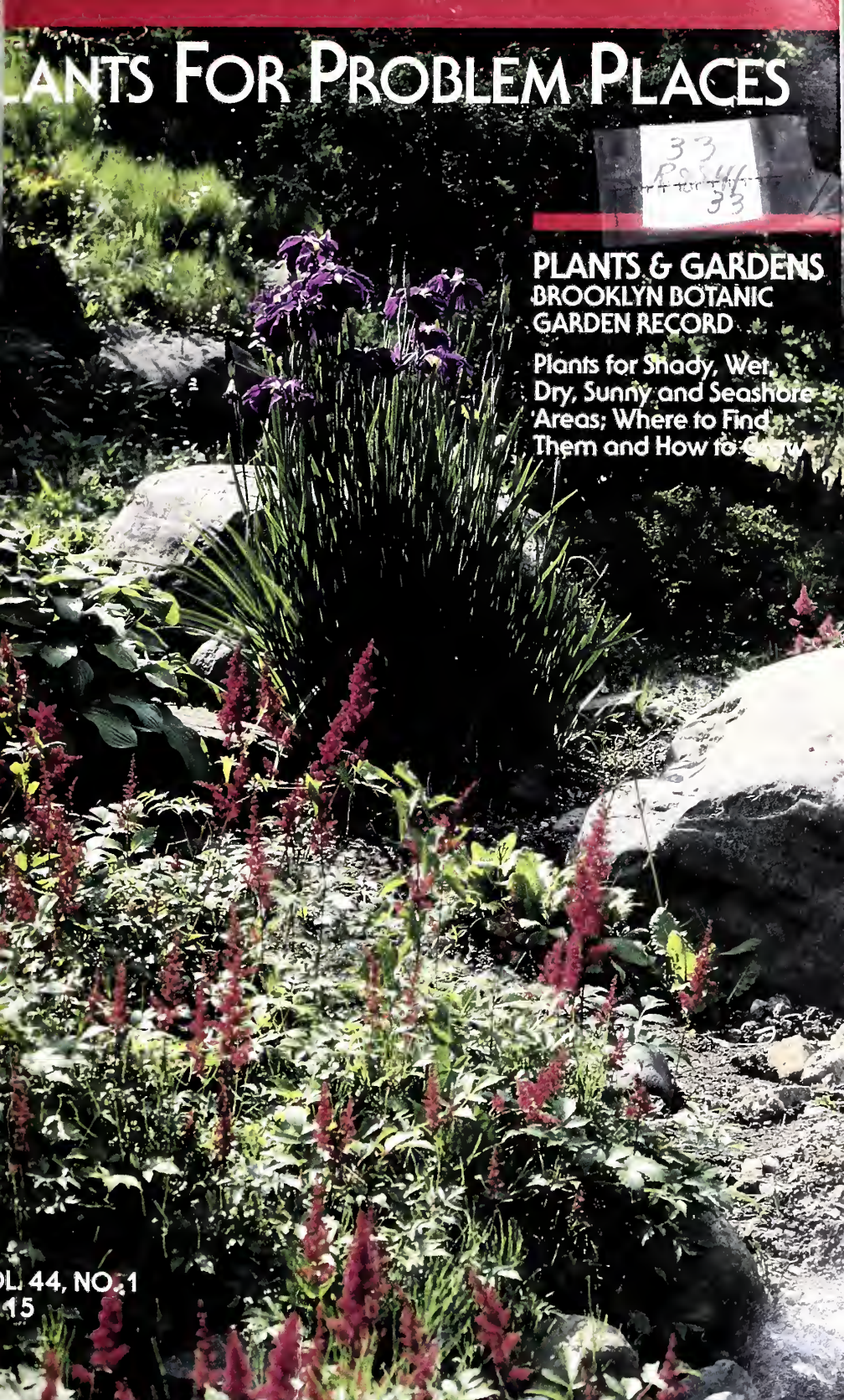
LANTS FOR PROBLEM PLACES
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PLANTS & GARDENS
BROOKLYN BOTANIC
GARDEN RECORD
Plants for Shady, Wet,
Dry, Sunny and Seashore
Areas; Where to Find
Them and How to
OL. 44, NO. 1
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PLANTS & GARDENS

BROOKLYN BOTANIC GARDEN RECORD

Plants for Problem Places

1988

Brooklyn Botanic Garden

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PLANTS & GARDENS
BROOKLYN BOTANIC GARDEN RECORD

Plants for Problem Places

Vol. 44 1988 No. 1

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Brooklyn Botanic Garden's Rock Garden in Spring
Cover photograph by Elvin McDonald

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foreword

Difficulties encountered in the garden are often the result of inappropriate plant selection. Plant groups have different cultural requirements involving such factors as moisture, light, drainage, fertility, pH (acidity) and temperature. Even a novice gardener would be unlikely to try a palm tree outdoors in Maine or Minnesota. Yet equivalent errors are inadvertently made.

When we look at natural areas there are plants in diverse array. Shady forests, sunny meadows, pond and stream banks, high mountains and dry deserts—all are vegetated. Each area has a unique appearance and plant life. The spring wildflowers of a northern woodland would dry to a crisp and die if planted in a Florida seacoast garden. Delightful little alpine plants from the Rocky Mountains often are distressed at the heat and humidity encountered at lower elevations.

All right, you say, so far all you've told me is that it is difficult to grow plants. Not quite. What I am trying to indicate is that by careful plant selection, problems are reduced and often eliminated. Matching the growing requirements of the plants to the conditions of the garden site make the gardener's task much simpler.

Often there is a combination of factors to be considered. A site is shaded, and also dry. Or, a location is wet, but only part of the year. Perhaps a coastal garden has bright sunshine, extremely quick drainage (sandy soil) and low fertility. There are plants which need just these particular conditions in order to grow well. But there will be three different sets of plants for the three different habitats.

"I have a spot in my garden where nothing will grow."

Plants often give us a clue to their cultural needs through their appearance. Those needing full sunshine and good drainage have developed some mechanism to reduce water loss. Perhaps, like seaside goldenrod, they have a waxy cuticle, or outer layer on the leaves. Or, leaf surface may be reduced, as with the brooms. Maybe the leaf is covered with grey felty hairs, as is common with so many herbs such as lamb's ears. Or, they may have succulent swollen leaves which store water, like sedums. Generally most of these plants will also have deep roots, growing down to where the scant moisture may be available. Such conditions are common to sandy coastal areas, and to deserts. And gardeners who live in such areas would be well advised to select plants which thrive under these situations.

Short of the polar ice caps, there are plants growing. All too often we carry the baggage of previous experience that colors our expectations, our image of what a garden should be. Transplanted Easterners yearn for the green lawns of New England. This is not what naturally occurs in Phoenix, Arizona or Denver, Colorado. And the intense manipulation of the environment in order to grow grass has literally begun to change the climate of these two cities. Matching *appropriate* plants to the environment creates an easy-to-grow garden.

Judy Glattstein,

Guest Editor

Smaller Shrubs for Problem Habitats

Gary L. Koller

The first chore of the gardener in selecting plants for any landscape is to determine existing habitat conditions. Will the plant grow in sun or shade, wet or dry soil, sheltered or windy exposure or subjected to salt spray. Gardening is made much easier if we look at the existing conditions as an opportunity to select plants which adapt to these conditions. Too often gardeners frustrate themselves and ultimately the plants, by spending time, money and energy on inappropriate environmental modifications. The specific environments which follow should be viewed as opportunities rather than limitations to garden development.

Shrubs For Moderately Shaded Environments: How does shade limit planting choices? Shade from buildings, trees or hills obstructs and diminishes the amount of light available to plants and reduces their ability to manufacture food. Plants may languish or stretch to obtain better light and as a result become thin and open. The shrubs listed below adapt to degrees

Gary L. Koller, Managing Horticulturist at Harvard's Arnold Arboretum, is co-editor of P&G*'s "Ground Covers and Vines."*

Juniperus horizontalis *covers this bank nicely. It provides a pleasant contrast to the grass.*

Rosa rugosa *grows naturally in sand close to the ocean. With its glossy green leaves, flowers in white or pink and large red hips, it makes an attractive oceanside hedge.*

of shade varying from light to moderate to dense; success depends on matching the species to its degree of shade tolerance.

Chamaecyparis obtusa—Dwarf cultivars (Hinoki false cypress)

Height: 3-8 feet depending on cultivar; evergreen; hardy to-20 °F; native to Japan.

More shade tolerant than most pines, spruces and firs. Slow growing. Foliage is a lustrous dark green, presented in layers providing a distinctive surface texture to the plant. Easily maintained at a size by pruning once each year. Excellent hedging material.

Clethra alnifolia (Summersweet)

Height: 3-8 feet; deciduous; hardy to -35 °F; native to eastern U. S.

Distinctive for late summer with fragrant flowers, exceptional shade tolerance and adaptability to wet and poorly drained soils. It also thrives in normal garden soils. In all situations the plant requires an acid pH. 'Rosea' and 'Pink Spires' are cultivars bearing pink blossoms.

Euonymus fortunei (Winter creeper)

Height: variable—from ground cover to 4-6 feet—depends on cultivar selected; evergreen; hardy to -25 °F; native to China.

Tough, adaptable, readily available and long-lived. Cultivars allow selection for types which vary from ground covers to shrubs. Variegated or colored foliage can add spots of color year-round, to landscape sites too shady for other plants to blossom. Quite shade tolerant, thrives in the urban environment. Susceptible to scale insects when grown in nutritionally poor soils or if subjected to extreme drought.

Hydrangea arborescens (Hills-of-snow hydrangea)

Height:3-5 feet; deciduous; hardy to -35 °F; native to southeast U.S.

Extremely shade and drought tolerant. Bears creamy white flowers in mid-summer which remain attractive for many weeks. Blossoms dry on the plant making them useful for autumn floral arrangements. Attractive as a specimen plant but most visually effective when mass planted. Inexpensive and readily available in nurseries.

Hydrangea quercifolia (Oakleaf hydrangea)

Height: 4-6 feet; deciduous; hardy to -10 °F; native to southeast U.S.

Bold architectural foliage in summer with dark bronze-purple autumn color. Showy white flowers in mid-summer which fade to pink, then light brown.

Ilex crenata (Japanese holly)

Height: generally 3-10 feet; evergreen; hardy to 0 °F to -10 °F depending on cultivar selected; native to Japan and Korea.

Broadleaf evergreen holly which can be grown informally or sheared for formal effects. Female plants bear small, pea-shaped black fruit. Two cultivars which are more cold hardy for northern locations include 'Convexa' and 'Helleri'.

Kerria japonica 'Picta' (Variegated Japanese kerria)
Height: 2-4 feet; deciduous; hardy to -20 °F; native to China.

Creamy white markings in the green leaves provide a lightening effect in the gloom of oppressive shade. Single, pale yellow flowers are borne in spring but they are unremarkable ornamentally. A tidy and neat shrub, handsome in winter because of its bright green stems.
Rhododendron carolinianum (Carolina rhododendron)
Height: 3-6 feet; evergreen; hardy to -20 °F; native to North and South Carolina and Tennessee.

Many rhododendrons are fairly small in stature; some are difficult to obtain, some are slow growers or possess horticultural limitations. *Rhododendron carolinianum* is included because it is small in stature, readily available and dependable if thoughtfully sited. In Boston, Massachusetts, flowers appear in mid-May in shades varying from white to pale rose. While all rhododendrons will tolerate shading, the degree or intensity of shade greatly affects habit and density as well as flower and fruit production. Optimum floral production is achieved in light or open shade.
Rhodotypos scandens (Jetbead)
Height: 3-6 feet; deciduous; hardy to -20 °F; native to Japan, China and Korea.

An excellent and dependable background or filler shrub. Leaves are medium green, deeply impressed with veins and upon close inspection, quite attractive. Foliage turns a pale yellow and is one of the plants to defoliate in the autumn. Flowers are small, single white and sparingly scattered over the plant in Spring. Long-lived and low-maintenance if left to grow informally.
Sarcococca hookerana var. *humilis* (Dwarf Himalayan sarcococca)
Height: 2 feet; evergreen; hardy to 0 °F; native to the Western Himalayas.

A tough, stoloniferous shrub which bears dark green, glossy willowlike foliage. Excellent as a specimen plant but most useful as a ground cover. Rare in the nurseries but well worth the search.
Sasa veitchii (Veitch bamboo)
Height 2-4 feet; evergreen; hardy to -10 °F; native to Japan.

This is a vigorous, spreading bamboo which needs to have its outward growth contained by in-ground physical barriers. Foliage is green throughout the summer; the onset of short autumn days triggers the development of a tan marginal band on each leaf. This coloration is striking in the winter landscape. Extremely useful on steep, shaded banks where it can colonize as much area as it wishes. Ultimate summer height can be reduced by mowing this plant early each spring.
Taxus cultivars (Yew)
Height: from 2 feet to small trees depending on cultivar; evergreen; hardy to -20 °F; native to Europe and Asia.

Tough, long-lived, adaptable, dependable and easily cultivated. Tolerates heavy shearing. Does not thrive in wet or poorly drained soils. Selections exist with yellow and variegated foliage and these are most useful in shaded sites where one wishes a spot of color. Useful selections which are readily available include: *Taxus baccata* 'Repandens' 2-4 feet tall and 8-12 feet across with elegant dark green foliage which droops at the tips, hardy to -5 °F; *T. cuspidata* 'Nana', becomes wider than tall and growth is easily controlled by annual shearing. Yews are excellent for hedges, barriers and foundation plantings.

Shrubs for Drought Stricken Environments:
How does drought limit planting choices? All life functions within a plant require water. Many plants have adapted to drought conditions by more efficiently utilizing available water; by synchronizing life cycles to produce active growth only when water is available, or by developing specialized tissues to maximize water storage or prevent water loss. The following plants are more drought tolerant than most:
Arctostaphylos uva-ursi (Bearberry)
Height: 6-12 inches; evergreen; hardy to -50 °F; native to northern areas around the world.

Forms a mat which can vary from dense to quite sparse depending on the site conditions. It will grow in full sun to light shade, requires an acid, well-drained soil. Summer foliage is a glossy olive green and in winter, purple-bronze.
Berberis x *mentorensis* (Mentor barberry)
Height: 4-5 feet; deciduous; hardy to -20 °F; hybrid origin.

Bushy and rounded. The dark green leaves turn muted colors of red and orange in autumn and are held very late into fall or early winter.

Bears stout and sharp spines making this an effective barrier plant. Yellow flowers in mid-spring.

Caragana arborescens 'Nana' (Dwarf Siberian pea-shrub)

Height: 5-6 feet; deciduous; hardy to -50 °F; native to Siberia and Mongolia.

At maturity an upright oval shrub. Produces yellow pealike flowers in spring. Tolerant of nutritionally poor soils, intense cold, salt spray and high winds.

Comptonia peregrina (Sweet-fern)

Height: 2-3 feet; deciduous; hardy to -50 °F; native to northern North America.

In New England this is one of the first shrubs to colonize the steep, sunny banks carved along highways. It seems to thrive on drought and nutritionally poor soils. Foliage is dark green and fragrant when crushed.

Cytisus scoparius (Scotch broom)

See discussion under *Shrubs for Saline Conditions.*

Indigofera gerardiana (Gerard's indigo)

Height: 3-10 feet; deciduous; hardy to -5 °F; native to the Himalayas.

In warm climates this plant becomes quite large but in the north it often suffers twig die-back from winter cold. At the Arnold Arboretum we cut it to the ground each winter, treating it as one would an herbaceous perennial. It blooms on new season's shoots beginning in mid-summer and lasting for two to three months. Blossoms are rose-pink and foliage is gray-green.

Juniperus conferta (Shore juniper)

See discussion under *Plants for Saline Environments*

Juniperus horizontalis (Creeping juniper)

See discussion under *Plants for Saline Environments*

Ligustrum obtusifolium regelianum (Regel's privet)

Height: 4-5 feet; deciduous; hardy to -35 °F; native to northern China.

A dense, multistemmed, horizontally-branched shrub. Produces creamy white flowers in mid-summer followed by small blue-black fruits.

Potentilla fruticosa (Bush cinquefoil)

Height: 1-4 feet; deciduous; hardy to -50 °F; native to the northern hemisphere.

Along the walkway, a low-growing Juniperus *species provides an interesting ground cover. Most species are drought, wind and salt tolerant.*

A compact summer-flowering shrub. Depending on the cultivar, it can bear white, yellow, orange to reddish-orange blossoms. Flowers appear four weeks or more during midsummer. It thrives in full sun, poor dry soils and extremely cold winter locations.

Rhus aromatica 'Gro-Low' (Gro-low fragrant sumac)

Height: 2 feet; deciduous; hardy to -50 °F; native to eastern North America.

Forms a low, wide-spreading mass. Relatively insignificant pale-yellow flowers occur in spring before the leaves develop. Summer foliage is a medium green and in autumn it turns burgundy to bright red.

Santolina chamaecyparissus (Lavender cotton)

Height: 1-2 feet; evergreen; hardy to 0 °F; native to Southern Europe.

Distinctive because of silvery-gray foliage all year-round. Flowers are small, golden yellow and borne in mid-summer. Can be clipped or sheared into miniature hedges.

Vaccinium angustifolium (Lowbush blueberry)

Height: 1-2 feet; deciduous; hardy to -50 °F; native to northeast North America.

In New England this plant forms thickets in dry deciduous forests where the competitions for light and water is intense. It flowers in spring with a typical creamy-white, urn-shaped flowers and produces small edible blue-black fruits in mid-summer. The autumn foliage turns yellowish or reddish bronze depending upon the exposure to light. This plant can be mowed occasionally to keep it dense. It requires an acid soil pH.

Yucca filamentosa (Adam's needle)

See discussion under *Plants for Saline Environments.*

Shrubs for Wet and Poorly-Drained Soil Environments:

How does wet soil limit planting choices? Each plant, in order to obtain soil oxygen and eliminate toxic gases produced by respiration, needs a certain balance of moisture and air in the pore spaces of the soil environment. Plants which thrive in swamps or flood plain areas have adapted their gas exchange and soil chemical uptake to tolerate poorly-aerated soil conditions both in nature and in gardens.

Aronia arbutifolia 'Brilliantissima' (Red chokeberry)

Height: 6-8 feet; deciduous; hardy to -20 °F; native to eastern and central North America.

A multistemmed, colonizing shrub. It grows naturally in low, seasonally wet sites. Small, creamy white flowers occur in spring, followed by large quantities of brilliant scarlet fruit in the autumn. Brilliant red autumn foliage color is best achieved in an exposure of full sun.

Cephalanthus occidentalis (Button-bush)

Height 3-6 feet; deciduous; hardy to -10 °F; native to eastern and central sections of North America.

This plant is rarely offered in the nursery trade but it is widespread as a native American plant. It thrives in boggy soils and in shallow standing water. Valued for green glossy summer foliage and creamy white flowers resembling hairy golf balls. Flowers appear in late summer.

Chamaecyparis thyoides 'Conica' (Dwarf white cedar)

Height: 5-7 feet; evergreen; hardy to -35 °F; native to the eastern coastal U.S.

Rosa rugosa *grows in the dunes close to the ocean. This adaptable plant forms dense thickets and is attractive through many seasons.*

In the wild this plant occurs almost exclusively in wet, fresh water locations such as swamps, wet depressions and along stream banks. New season foliage is blue-green and winter color is brown-green. Must have full sun. The cultivar 'Conica' is compact, slow-growing and forms a number of leaders giving the appearance of a craggy mountaintop.

Clethra alnifolia (Summersweet)

See discussion under *Shrubs for Shade*

Ilex glabra 'Compacta' (Compact inkberry holly)

Height: 3-5 feet; deciduous; hardy to -20 °F; native to eastern U.S. Full sun to moderate shade.

This broadleaf evergreen is slow-growing and dense and suckers to form colonies in the wild. It has lustrous green foliage in summer becoming more yellow-green in winter. Bears small black fruits which are visually interesting close up. Best growth is achieved in acid soils.

Ilex verticillata 'Red Sprite' or 'Nana' (Red Sprite winterberry holly)

Height 3-5 feet; deciduous; hardy to -35 °F; the species is native to eastern North America.

An autumn drive on the Maine Turnpike will reveal these native shrubs growing in wet locations along the roadway, bearing small, bright-red fruits. This is winterberry which grows in colonies or thickets normally six to ten feet in height. The cultivar 'Red Sprite' is also offered in the nursery trade as 'Compacta' and 'Nana'. This selection has larger fruit than the typical species while the mature habit is more compact. When planting this species one needs to plant one staminate (male) plant for every 10 to 12 pistillate (female) plants. Full sun.

Itea japonica 'Beppu' (Beppu Japanese sweetspire)

Height: 2½-3 feet; deciduous; hardy to -5 °F; native to Japan.

A rapidly growing shrub which colonizes a site via underground stems. The fragrant, creamy-white flowers occur in mid-summer and last one to two weeks. Autumn foliage color is reddish-purple. This plant is best used in large masses as a ground cover. It can be kept neat by mowing it to soil level occasionally. Full sun to light shade.

Rhododendron canadense (Rhodora)

Height: 1-4 feet; deciduous; hardy to -35 °F; native to northeastern North America.

A rare native azalea valued for its bright showy rose-pink flowers which appear before the leaves in spring. Plant habit is rather sparse and open. Requires an acid pH. This species is both difficult to obtain in nurseries and more demanding of proper environmental conditions than many rhododendrons. Full sun to light shade.

Potentilla fruticosa *is a compact summer-flowering shrub that thrives in full sun, poor, dry soils and extremely cold winter situations.*

Rhododendron viscosum (Swamp azalea)

Height: 1-6 feet; deciduous; hardy to -35 °F; native from Maine to Georgia in Swamps.

Bears fragrant white to pale-pink blossoms in early summer. Summer foliage is often bluish green and in autumn turns a bronze prior to defoliating. Full sun to light shade. Requires an acid soil pH.

Salix purpurea 'Nana' (Dwarf purple osier willow)

Height: 3-5 feet; deciduous; hardy to -35 °F; native to Europe and Asia.

This willow bears slender, fine-textured, silvery-gray leaves. Can be used informally or sheared for hedging purposes.

Prunus maritima, *beach plum, is native from Maine to Virginia. It grows in sandy soil, often close to the ocean. The fruit is edible.*

Sasa veitchii (Veitch bamboo)
See discussion under *Shrubs for Shade.*
Thuja occidentalis (Eastern arborvitae)
Height: 4-40 feet depending on cultivar; evergreen; hardy to -40 °F; native to eastern North America.

Numerous cultivars have been made from this species selecting individuals exhibiting dwarf and slow-growing characteristics—many will remain 3-5 feet tall, and as wide or wider, almost indefinitely. The species tends to turn a yellow-green in winter but several cultivars have been selected for a greener more lustrous winter appearance. Best growth occurs in full sun to light shade. Extremely tough and hardy.
Xanthorhiza simplicissima (Yellow-root)
Height: 2-3 feet; deciduous; hardy to -35 °F; native to the eastern U.S.

The ornamental features of this plant are limited to bright green celerylike leaves and clear yellow autumn foliage color which occurs later than in most shrubs. This plant thrives in soils which vary from dry to wet and from full sun to moderate shade so it becomes useful to blend plantings from one set of environmental conditions to another. It is best used as a filler or background shrub or as a ground cover.

Shrubs for Environments Subject to Ocean or Highway De-icing Salts:
How does environmental salt limit planting choices? Salt spray will cover buds, twigs, leaves and stems of plants and may cause chemical burn of the plant tissue. De-icing salts penetrate the soil environment and interfere with a plant's ability to absorb water and other chemicals from the soil. Plants which thrive in high saline environments have developed mechanisms to reduce the effects of high salt levels on their metabolism.
Cytisus scoparius (Scotch broom)
Height: 4-6 feet; deciduous; hardy to -10 °F; native to central and southern Europe.

Tolerates both drought and salt spray. During late spring this plant bears pealike blossoms which can vary from yellow to dark red depending upon the cultivar selected. The plant forms a broad mound and is attractive in winter because of slender bright green stems. Requires full sun. Will naturalize, by seeds, into favorable sites.
Diervilla sessilifolia (Southern bush honeysuckle)
Height: 3-5 feet; deciduous; hardy to -20 °F; native to the southeastern U.S.

A low shrub which forms a multistemmed thicket. Small yellow flowers which appear in mid-summer are attractive when viewed up close. Foliage turns a bronze to purple in the autumn, or during summer when it is subjected to drought stress.
Genista sagittalis (Arrow broom)
Height: 1 foot; evergreen; hardy to -20 °F; native to central and southern Europe.

A low mat-forming plant which will grow on and help stabilize sand dunes. Small, bright golden flowers appear in late spring. The plant is evergreen but in winter the foliage hugs the ground.
Hydrangea macrophylla (Bigleaf hydrangea)
Height: 3-6 feet; deciduous; hardy to 0 °F; native to Japan.

Bigleaf hydrangea is the type which bears huge globe-shaped flower heads in late summer and the flower color varies from bright blue to rose-pink depending on the soil pH. Thrives in full sun to light shade. *Please note:* this species of hydrangea blooms on two-year-old wood so pruning needs to be done thoughtfully.
Juniperus conferta (Shore juniper)
Height: 1-1½ feet; evergreen; hardy to 0 °F; native to Japan.

Found naturally along the seacoast of Japan. Forms a dense, prostrate mat with a bright blue-green color throughout the year. Requires full sun and well-drained soils.

Juniperus horizontalis cultivars (Creeping juniper)
Height: 1-2 feet; evergreen; hardy to -35 °F; native to northern North America.

Summer color varies from yellow-green to dark green to blue-green and winter color can be green to blue-grey or bronze-purple depending on the cultivar selected. Often used in mass plantings as a ground cover. Quite susceptible to twig blight which causes leaves and twigs to turn brown and die back. Drought, wind and salt tolerant.

Pinus mugo var. *mugo* (Compact mugo pine)
Height: 6-8 feet; evergreen; hardy to -40 °F; native to central and southern Europe.

This evergreen species is quite variable when grown from seed and can vary from a prostrate shrub to a small tree 20-40 feet tall. Therefore, for compact growth, one needs to select cultivars for dwarf habits.

Prunus maritima (Beach plum)
Height: 4-6 feet; deciduous; hardy to -35 °F; native from Maine to Virginia.

Forms a dense, rounded mound. Produces white flowers in mid-spring followed by small purple, edible plums.

Rosa rugosa (Salt spray rose)
Height: 4-6 feet; Deciduous; hardy to -40 °F; native to China, Korea and Japan.

In New England this rose grows directly in sand dunes within sight of the ocean where it forms dense thickets. Flowers are produced over a period of many weeks and blossoms are normally rose-purple but can be white or double. Fruits are a bright orange-red rose hip which are showy against the dark green crinkled foliage. Autumn leaf color is a purplish-bronze.

Robinia hispida (Bristly locust)
Height: 3-8 feet; deciduous; hardy to 0-10 °F; native to central and southern U.S.

A vigorous and invasive colonizing shrub which is ideal for stabilizing soil on banks or difficult, dry, sunny locations. Showy pealike flowers in early summer for a period of about two weeks in colors varying from pale rose to purple. Stems and branches bear spines which makes this an effective barrier shrub.

Yucca filamentosa (Adam's needle)
Height: 1-2 feet in leaf and 3-6 feet in flower; evergreen; hardy to -25 °F.

Bold sword-shaped leaves and tall panicles of creamy white flowers in mid-summer, make this a dramatic plant for the home garden. It is remarkably tough and persistent in poor dry soils, in seacoast locations and for rooftop gardens. New cultivars have introduced cream and golden strips in the foliage which is especially striking in the winter landscape.

Ilex crenata 'Helleri' is dwarf and compact, looking almost as if it had been trimmed. Here it works well as a hedge.

PLANTS FOR THE CITY GARDEN

Timothy Steinhoff

Gardening in a landscape dominated by steel and concrete is a challenge. Here is an atmosphere where light is fleeting in the shadow of another skyscraper. Yet there are

A small city garden is bisected by a stepping-stone path with borders containing ferns, English ivy, crabapple and wisteria.

A two-level city garden contains rhododendrons, ground covers and several small trees.

scores of verdant spaces such as public parks, community gardens, vest-pocket parks and terraces.

Conditions vary from site to site, mandating careful scrutiny. Run a soil test to determine pH and fertility, survey light patterns and air pollution, and measure wind and air circulation. There are many man-made obstacles to consider; overhangs which prevent rain from reaching a plant's roots, alkaline debris and ruptured steamlines which can force plants into suicidal premature growth in mid-winter.

Surprisingly, the most common cause of urban gardening failure is improper watering. City plants are dependent on man for deep, regular watering. A plant that is allowed to wilt will never reach its full potential and will be weakened. A deep three-inch mulch or a ground cover will insulate a plant's root zone and moderate the fluctuation of soil temperature and evaporation. Plants, especially evergreens, benefit from a weekly hosing down of their foliage, including the undersides of the leaves.

The most critical factor to consider when matching plants to a site is the amount of available light. Shady sites, where there is less than four hours of sun a day, offer the opportunity to create a landscape composed of varying foliage colors, textures, and contrast in leaf shape and size. If your garden has sufficient light for impatiens to flower, then there is a variety of other plants that will provide flowers and colorful fruit. Paley Park in midtown Manhattan is a shady vest-pocket park composed solely of honey locust trees and ivy, but it is a cool, green retreat. Unhealthy, light-starved plants are never attractive. Plants that are well suited to a garden's light conditions will thrive and require a minimum of care. Select carefully.

Concrete and asphalt absorb heat during the day and release it at night as the atmosphere cools. In summer this results in a situation where temperatures may vary little from day to night. Many woodland plants that are well adapted to shady conditions will not tolerate evening temperatures that don't drop below 70 °F for weeks on end. Popular bedding and hanging basket subjects such as tuberous begonias and fuchsia also fit in this category. In winter this phenomenon can result in warm temperatures during a bright, sunny day with a steep drop at night. A mulch during the cold months will moderate the destructive effects of this freezing and thawing. It should be applied after the ground has frozen and be removed in early spring.

Dry shade, caused by woody plants with surface roots, is the most limiting factor in choosing plants. This commonly occurs in gardens planted with maples or the ubiquitous ailanthus

Timothy Steinhoff, Brooklyn, New York, is the owner of The Perennial Plantsman, a garden design and consulting firm. He has gardened in New York City for 15 years.

Photo by Goldsobo-Schleisner

A small flagstone terrace is surrounded by ground covers, spring flowering bulbs and small shrubs. Large trees form overhead canopy.

and privet. They create dense shade and are voracious consumers of water and nutrients making it next to impossible for other plants to succeed.

If the limiting factor is light, use different forms of plants that you know will thrive, such as the many types of holly and English ivy.

Be selective in your choice of plants, choosing those that have more than a single season of attractiveness or long periods of interest. Texture, leaf shape and luster, and plant profile are as important as an often brief period of bloom. Don't overwhelm your garden with plants that will grow too large for your space. Compact forms of many of the most popular plants are available. My experience in urban gardening has taught me to experiment and always be on the lookout for new plants and new ways to use familiar ones. Change a planting when it is not successful.

Public planting works best when it is simply executed, utilizing large masses of a few plants, usually in separate colors. There are many visual distractions in a city, and planting needs to be bold to catch the eye. In New York City, a small windswept park across from the United Nations headquarters, is planted with a mass of the single pink rose, 'Betty Prior' which can be seen a block away from May to November. A nearby three-story wall which was an eyesore has been "upholstered" with Boston ivy to give the park a softer, more unified appearance. An allée of London plane trees underplanted with English ivy is enlivened by scattered drifts of narcissus in the spring and then astilbes in groups of six or more of each variety, using several varieties to prolong bloom over many weeks.

Public parks can be given additional appeal by underplanting shrubs and bulbs with plants of a contrasting color and texture. White tulips when underplanted with blue forget-me-nots, or roses underplanted with fragrant grey lavender are not only more visually arresting but also give you more display for nearly the same amount of maintenance.

Use plants with fragrant flowers and foliage, a pleasant surprise for the passerby. A large bed of nicotianas of three different types, 'Nicki,' *N. sylvestris* and *N. alata,* give a Victorian air to historic Union Square Park in N.Y.C. The latter two varieties are very fragrant in the evening.

To discourage destructive wildlife, avoid plants that require staking or frequent spraying in order to remain healthy. A sturdy fence will discourage dogs. Pigeons, rats and squirrels when present in large numbers, are equally destructive. Feeding should be discouraged.

Most public plantings are adjacent to public paths and plazas—hot in summer and frequently spread with salt in winter. In summer this provides the ideal condition for the rapid spread of spider mites, sucking insects which

quickly debilitate a planting. Any plant that is already stressed is an ideal candidate for this pest. Frequent washing down of the foliage and periodic spraying with a miticide such as Safer insecticidal soap should keep it in check.

Private spaces can be more personal in character. If containers are used they should be a minimum of 12 inches wide and deep for annuals, and 18 inches deep for perennials and shrubs. Plantings should provide color and interest for the times of the year that the space is most used. Allow enough space so that plants can develop naturally graceful profiles. Leave pockets for long-blooming annuals that can be changed year to year.

The list of plants possible is varied. Choose a plant form that will be in scale with the space. City gardening is a commitment to ongoing care, as plants are more dependent on us than are their rural counterparts.

Plants for Dry Shade (roots)

Lily of the Valley, Solomon's Seal, *Epimedium,* Old Fashioned Bleeding Heart, Gooseneck Loosestrife, and *Paxistima*

Plants for Shade (less than 4 hours of sun)

Skimmia, Abelia grandiflora, Cherry Laurel, *Ilex meserveae, I. glabra, I. pendunculosa, I. crenata, Laburnum vossi, Viburnum prunifolium, V. rhytidophyllum, Aucuba japonica* (various forms esp. plain green), *Hamamelis mollis* (fragrant), *Kerria* (esp. the single), *Taxus* (esp. the graceful *repandens*), *Hydrangea macrophylla* (esp. the lacecap type), *H. quercifolia* (wonderful peeling bark and ruby fall color), Boxwood, *Leucothoe,* Rose of Sharon (Be sure to prune in spring so blooms are at eye height in summer.), azaleas and small leafed rhododendrons, yellow groove bamboo, *Sophora japonica, Cornus kousa, Halesia carolina, Amelanchier laevis, Bergenia, Anemone japonica, Pulmonaria, Aquilegia, Thalictrum, Astilbe, Hosta, Liriope,* ferns (esp. the lady fern *Athyrium filix-femina),* Day lilies, silver fleece vine, *Clematis paniculata, Akebia quinata.* Also *Vinca minor, Pachysandra,* English Ivy, Boston Ivy and Virginia Creeper, Snakeroot, *Brunnera, Heuchera, Digitalis, Primula,* Sweet woodruff, *Helleborus orientalis, Impatiens, Caladium,* and *Nicotiana.*

Plants for Hot & Dry Places

Artemisia, (various) *Kniphofia* (esp. the creamy white Vanilla), *Coreopsis* (esp. the threadneedle *verticillata), Echinacea, Lychnis coronaria, Gaillardia,* sedums, roses (esp. rugosa), floribundas (esp. 'Betty Prior' who will also tolerate light shade as will the hybrid musks and climber 'New Dawn'), Junipers, grapes, *Gazania, Heliotrope, Santolina,* lavender, *Perovskia, Yucca filamentosa, Lantana, Salvia farinacea,* snapdragons, *Wisteria.*

Plants for Windy & Sunny Places

(Spray anti-dessicant Dec. 15 & 6 weeks later.) Siberian Pea tree, rugosa roses, juniper, Japanese black pines, *Yucca filamentosa,* Russian and Autumn olive, flowering crabs, and most annuals and perennials listed for sunny places above.

A fountain provides the focal point in this garden where containers are placed here and there for added interest.

Photo by Gottscho-Schleisner

HIGH ALTITUDES
GARDENING THE UPLAND WEST

Panayoti and Gwen Kelaidis

What is High Altitude Gardening?

Even a cursory glance at a topographic map of the United States will reveal that the western half of the country has a higher altitude than the eastern. The mean elevation of the state of Colorado is more than 7,000 feet, and the entire Great Basin is only slightly lower. The bulk of America's national parks, monuments and public lands are situated in the Upland West, and people come here from all over the world to enjoy the scenery and wealth of wildflowers that have evolved in this intricate landscape. Considering the richness of the native flora, it's ironic that many people who live here complain about how hard it is to grow plants in their gardens.

Gardeners in the upland West face a host of challenges. This is a region generally defined as west of the 100th meridian and east of the Sierra and Cascade Crests, with elevations above 4,000 feet, and receiving annual precipitation of 5-25 inches. Horticulture is new here, both because European settlement started scarcely a hundred years ago, and because the introduction of modern irrigation has only recently transformed the establishment of new gardens from sheer drudgery to a ready possibility. Horticultural practices imported from maritime areas, such as northern Europe, the eastern U.S., and the Pacific Northwest, have limited application here. As a consequence the West is reputed to be a difficult place to garden.

The Upland West is a highly diverse environment. It includes a latitudinal area from Montana to the Mexican border, elevations which climb over 14,000 feet, and a temperature range from -60 °F to well over 100 °F. Along the Mexican border frost is light and transient, and subtropical plants will often survive at several thousand feet elevations, while similar altitudes along the Canadian border experience sub-zero cold for months on end. The Southwest receives more days and degrees of sunshine than the Mediterranean Basin.

The different combinations of altitude, latitude, sun, rainfall and soils, make gardening generalizations for the entire region impossible and because the area is sparsely settled, there is not a large reserve of experience to draw on for any given area. Gardeners new to the region find this difficult to accept.

Soils

The West is full of badlands, hoodoos, buttes, mesas, arroyos, mountains, deserts and a wild topography that sometimes resembles nothing so much as the face of the moon. Even in less dramatic areas where cities and farms have been established the soils are affected by the forces that have formed the West. The general uplift and erosion that has taken place results in raw, mineral soils, which may have many nutrients, but are generally low in nitrogen and organic matter. The newcomer has to learn a new vocabulary for naming soils: bentonite, adobe, talus, caliche. Gardeners consider themselves lucky to have an even moderately loamy clay or sandy soil. These soils are not just an accident, but the natural product of many different substrates and a climate in which little humus is produced, and that quantity broken down quickly by weather.

Rather than fighting the natural conditions by trying to re-create the deep humusy soils of

The typical western terrain of mountain and valley is seen in this shot of Aspen, Colorado's Pike's Peak.

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coastal and woodland environments, western gardeners are challenged to create a new kind of horticulture appropriate to the climate, the restricted water, and the soil conditions that exist.

Climate and Microclimate in the West

Weather is an equal match to topography for variability and perversity. Hailstorms, floods, hurricane-force winds and whimsical frosts punctuate a gardening year that is characterized more or less by perpetual cloudless skies and burning sunshine—to put it bluntly, drought. Climate varies so much in this region of dramatic altitudinal relief that microclimate is paramount to understanding gardening needs and the potential of plants. A single ridge or mountain can separate a region characterized by USDA Zone 3 temperature extremes from one that fits Zone 6 quite nicely.

Montane Uplands and Dry Uplands

Ecologists have observed that there are two tree lines in the West: one separates the mountain forest from alpine tundra, and the other, separates the mountains from the Great Plains grassland and Intermountain sagebrush steppe. It is useful to distinguish between the forested, montane area of the foothills and the northern plains—the montane uplands; and the treeless areas of the plains and the high sagebrush— the dry uplands. These are the two major areas in which people now live and garden. From the gardener's point of view, the two regions are dramatically different.

The montane uplands are generally higher, somewhat moister and experience more dramatic shifts in diurnal temperatures. Soils here are usually acid and often gravelly. Heavy spring snowfall and alternate freezing and thawing lead to a devastating season of poor drainage in late spring. Garden plants must be able to tolerate long, cold winters and short summer seasons, with cold nights. Most settlement in the montane uplands has been near ski resorts and other recreational development, although suburban housing is extending more and more into the mountains near Missoula, Denver, Santa Fe and Salt Lake City.

Here a desert garden showcases native cacti.

Drought and sun are the limiting factors to horticulture in the dry uplands. Here trees give way to a climax vegetation of grass and herbaceous plants. Most urban development and farming in the West are in these dry uplands. Intense sun and desiccating winds are hallmarks of the steppe climate here, and plants of maritime origin need considerable irrigation and sometimes shade, to grow well. Soils tend to be heavy clays or sterile sand. Night temperatures are colder at all times of the year than in equivalent latitudes closer to sea level. The thinner atmosphere and low humidity contribute to rapid temperature change. Snow falls sooner in the fall and later into the spring season. The plants that adapt best to these conditions must be sun-tolerant and be adaptable to irregular moisture patterns. Surprisingly, many plants of Mediterranean origin do well, but the most useful garden plants for the West are the natives and those that originate in the steppe areas of Asia and the southern Hemisphere.

Gardening in the Western Uplands

Universities, botanic gardens, and horticultural extension agents are valuable sources for information on plants that have already been tested in a region. Amateur gardeners, with their boundless energy and willingness to try any beautiful plant, are often a step ahead of professionals in testing unusual plants. Seek outstanding gardens in your area, and consider joining local garden clubs to see what has been achieved. This way it is possible to build upon local experience.

Not all the plants which would be useful and enjoyable for planting in the uplands are commercially available. Many plants that grow here naturally, and the plants from similar climates around the world, are not yet in common cultivation. Much of the earth's surface consists of mountains and high drylands with conditions similar to ours, and countless plants from all over would grow well in the West. Some, especially those adaptable to conditions in maritime climates, are widely available. More are known but not yet available commercially, either because the nursery industry doesn't know them, or hasn't yet conquered the secret of how to propagate them profitably. As more and more gardeners settle here and bring their talents to bear on western gardening, look for many new plant introductions.

After choosing the plants you want to grow, see how you can improve your soil. It isn't necessary to convert all soils to a humusy, vegetable loam. Many plants will adapt to the heavy, native soils, provided they are not overwatered. Modify your site so that plants will be shown off to the very best advantage. Gardening is not only the science of growing the appropriate plants well, it is the art of growing them beautifully. The aesthetic arrangements of plants according to their qualities of leaf shape and flower is always the crux of successful gardening. Since a different palette of plants is available to the upland gardener, the combinations of plants should also differ, as well as the design of gardens.

Vegetables and Small Fruits

For the vegetable gardener, plants which prefer cool nights will be the most rewarding to grow. All the members of the cabbage family—cauliflower, broccoli, brussels sprouts, kale—will thrive in the montane uplands. Peas can be grown all summer, their blossoms never failing. Root crops, such as beets, turnips, and carrots also perform well, as well as lettuce and Chinese cabbage. In areas with sporadic frost, above 6,500 feet, all the cold-sensitive crops become impossible to grow without employing special strategies. Beans will be killed by frost, and corn, tomatoes, squashes and cucumbers, melons, peppers, and eggplant are all impossible. Dedicated gardeners may grow these plants by starting them in containers well ahead of the first frost-free date, then setting the containers out in the warmest weather, and bringing them inside whenever frost threatens. In marginal areas, tomatoes may be surrounded with water-filled plastic walls and the soil covered with black plastic to raise the temperature to the point where fruit will set.

In the dry uplands summer temperatures often reach higher levels, soils get much warmer, and the frost-free season lasts longer. All the traditional vegetables can be grown here in most years, with melons thriving in areas of sandy soils and heat. Tomatoes may ripen slowly if nights remain cool; they can be encouraged by methods which warm the soil. Irrigation is frequently a problem in the dry uplands. Evaporation is rapid because of low humidity and intense sun. Utilize mulches when possible, both to decrease water loss and to add organic

In the shadow of Mt. Rainier strawflowers (everlastings) dot the landscape.

matter to the soils. Watering is frequently regulated by local water boards. Even when it is not, try to water early and late, rather than in the heat of the day, and to water low; i.e., to use soaker hoses, soil flooding techniques, or sprinklers that keep the water low to the ground. This will minimize evaporation and maximize the amount of water which reaches plant roots.

When to Plant

In most of the dry uplands, plant during the cool, transitional months of the year. The intense sun and low humidity of summer make it difficult for plants moved at this time to recover their health. The gentle cooling weather of fall, followed by the relatively high precipitation of winter and early spring, gives perennials and woody plants the best chance to re-establish. Lower evaporation and less intense sun mean less stress for these plants. Over most of the West, container-grown plants and many natives may be successfully transplanted almost any time the soil isn't frozen, provided they are planted carefully, and watered properly.

In the montane uplands, with only a month or two of growing season, planting should be done as early in the summer as possible so that plants may thoroughly re-establish by frost. This is particularly true of trees or questionably hardy plants.

Trees for the Upland West

Trees are perhaps the missing element in upland gardens. In the dry uplands practically the only native trees are cottonwoods growing in river bottoms, and ponderosa pines and hackberries in the foothills. Because it was assumed that growing exotic trees would be difficult, for years the only trees commonly planted were cottonwoods, siberian elms, silver maples, box elders, junipers and blue spruces.

There are several trees native to the West that could improve diversity. Anyone who has driven through the Wasatch Mountains of Utah in October is aware that the West can rival the East in autumnal glory. *Acer grandidentatum* has occasionally been classed as a subspecies of the eastern sugar maple, and has a glorious strawberry-pink fall foliage color. Unlike the eastern maples, the Wasatch maple thrives on alkaline soils and minimal water. It quickly forms a graceful small tree of much the same size and landscape use as the Japanese maple of coastal climates.

Gambel's oak is but one of a number of striking western oaks that do well in a range of soils and conditions. A variety of native shadblows, larches and hemlocks might one day enrich the western gardens, but at present they are unavailable outside of specialty nursery catalogs.

Many trees from the northern reaches of the eastern woodlands and from colder areas in Eurasia have proven surprisingly adaptable well up into montane uplands. Many kinds of ashes, birches, elms, maples, rowans, oaks and sycamores will grow in a surprising range of altitudes, and other species will certainly one day join their ranks. The inland redwood, *Sequoiadendron,* and almonds grow reliably to 7,000 feet in the foothills of the Southwest, and a giant specimen of true cedars *(Cedrus),* albizzias and evergreen magnolias can be found in the urban forest of Denver and Salt Lake City.

Here pampas grass, native to western states, forms a hedge in this desert garden.

A Few Versatile Shrubs for the Upland West

The common Western rabbitbrush or chamiso *(Chrysothamnus nauseosus)* is an example of a western native that is widely propagated by nurseries, and will adapt to a remarkable range of soils and climates from the Sonoran Desert to dry subalpine parkland. The rich gold sweeps of chamiso blooming with the wild lavender asters create such a fall spectacle in parts of the Southwest that people make special pilgrimages to see them. Due to late frosts, forsythias bloom only spottily in many upland climates, while rabbitbrush blooms reliably for weeks on end every fall, bringing just as vivid a yellow to the garden. Provided it is watered as a small plant, rabbitbrush will adapt to the most meager soils and driest climates with no further attention.

Five of the most distinctive and striking native flowering shrubs are in the Rose Family. Ocean spray *(Holodiscus discolor)* produces spiraea-like mounds of neat, scalloped foliage that is obscured with huge cream panicles of bloom

much of the summer. Apache-plume *(Fallugia paradoxa)* has large, anemonelike flowers much of the summer, along with tousled, decorative achenes. The fragrant, white-flowered evergreen cliffrose *(Cowania mexicana)* is a special favorite of many westerners, forming small, graceful trees beautiful at all times of the year. Although the flowers on mountain mahogany are trivial, the lovely plant habit and showy, gracefully twisted seedpods can create a spectacle when backlit by the sun. There is tremendous variability in *Cercocarpus,* from the dwarf, evergreen *C. intricatus,* which generally grows only a few feet tall and broad to the small trees of *C. ledifolius* that resemble Mediterranean olive trees with silvery, gnarled trunks and elliptical, evergreen leaves.

Other little known western natives include littleleaf mock orange *(Philadelphus microphyllus)* and the compact, graceful evergreen hollyleaf oak *(Quercus turbinella).* Five species of manzanita occur east of the Sierra Crest which are hardy, have lovely evergreen foliage, showy flowers, bark, and colorful berries. These are aristocrats among the native shrubs; many more can be added to the list.

Herbaceous Plants for Western Gardens

At very high altitudes the cold limits horticultural possibilities. Night temperatures will rarely be above the forties even during hot spells. Some valleys have frost-free seasons of less than a month. Only a handful of native trees grow naturally in such climates, but many subarctic and subalpine trees from other regions may one day be introduced to enrich the woody plant palette of these areas. The most difficult areas to garden are the coldest, for these tend to be the least populated regions of all, with a short season in which to experiment, few gardeners, and virtually no nurseries catering to their needs.

The crisp summer climate and beautiful mountain scenery have led many ski resorts to promote a summer season. Considerable money is spent on planting showy beds of annuals. Alyssum and bedding pinks are especially good, with a certain tolerance to cool evenings; geraniums and marigolds are also widely used, and even petunias will perform well as long as the night temperatures don't dip too far below 32 °F. Pansies reveal their alpine ancestry and perennial nature by blooming lustily as long as they are free from snow, returning in spring to flower again. The iceland poppy—an annual at lower elevations—has become a hallmark of mountain gardens, attaining awesome size and blooming for months on end. It also proves to be perennial at these elevations.

Since bedding plants will usually suffer frost at these altitudes within 60 days, perennials are a more sensible investment. With the cool nights, each flower has richer color and lasts longer than in the warmer, lower elevations. Many species also bloom for a much longer season, sometimes longer than annuals. Perennials that thrive in these areas include delphiniums, true geraniums, pinks, shasta daisies, coral bells, columbines, Siberian iris, peonies, and poppies of all kinds. A few of the most glamorous garden plants require cool nights in order to grow at all: Himalayan blue poppies *(Meconopsis betonicifolia)* are impossible in most of the United States, but several species have bloomed reliably at 8,000 feet in Colorado. Virtually any species of primrose, saxifrage or gentian can be expected to grow better and live longer in high altitude gardens than in low.

A great number of annuals and perennials can be grown in gardens in the dry uplands. With irrigation and some soil preparation, almost any perennial that will grow on either coast can be adapted to some microclimate of this region. Naturally, those from similar climates will prosper. Most bulbs that are often temperamental in maritime climates are superlative here. Tulips will often improve with the years, and some, like *Tulipa kaufmanniana,* will naturalize from self-sown seed. Bearded and bulbous iris of all kinds are long-lived and free from borer or most viral diseases in this climate. Virtually any cold-tolerant plant in the mint, daisy or borage family will grow with ease in this climate.

Gardeners have been surprised that plants from the Southern Hemisphere are not only hardy, but excellent garden plants in parts of the dryland West: several iceplants from South Africa have become widely disseminated in recent years, notably the yellow-flowered *Delosperma nubigenum* with apple-green summer foliage and bright red winter foliage, and the ever-blooming, cerise-flowered *D. cooperi* proves hardy if it is kept dry and grown

Under the snowcapped Mt. Rainier, strawflowers grow wild.

on a harsh, mineral soil. *Crocosmia* and *Schizostylis* have been grown for decades in cooler microclimates, and such New Zealanders as the vegetable sheep *(Raoulia)* and South African calceolarias are reliable perennials in many local gardens.

The success of herbaceous perennials in much of the West should be no surprise—perennials dominate the native landscape over much of this region. It's only appropriate that they feature prominently in the cityscape as well.

Conclusion

Population in the West is so diffuse compared to other parts of the United States that only a few urban areas have been able to develop a local nursery and landscaping industry. Economic depression in recent years has actually led to a net decrease in population in several Western states. Nurseries are scattered so far apart that it is difficult for them to develop or maintain large inventories of plants. How can one expect nurserymen to develop regional plant varieties when giant nurseries from either coast or the Midwest can transport lush-looking, and often tender container stock into the region each spring more reasonably? Locally selected and grown plants may look less prepossessing, but quickly outgrow exotics.

Developing a regional nursery trade is obviously crucial to the further advancement of Western horticulture. Western upland gardening is unquestionably further behind any other region in the country. The plants currently in use are largely inappropriate, employing only a fraction of the plants available to adventurous gardeners. One day, gardeners with means and the proper plants at their disposal will create gardens as rich and beautiful as the national parks and forests here that are among our nation's greatest treasures. ⁂

IN THE WET

Judy Glattstein

Water is a constant problem in the garden. Lawns and herbaceous borders require an inch of water a week (two showers in a nice slow steady soak, scheduled between 11:00 p.m. and early morning, please). Often a plant is described as needing soil that is "moist but well drained." This seemingly contradictory advice is generally interpreted to mean that moisture is present but moving through the soil, not stagnant and standing. But what can be done if water is constantly present?

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A pond provides an opportunity to grow many aquatic plants. Shown here: water lily, iris and water hyacinth (which can be invasive).

A flagstone path meanders along a stream bordered with shade-loving primroses and spring bulbs.

A brook lined with a profusion of forget-me-nots, ferns and Japanese primroses is a lovely sight in spring.

First, analyze the conditions. Perhaps it is a pond, marsh or swamp with little water movement, or a stream, with consequent turbulence. Each of these combinations of factors influence the selection of plant material. Temperature, both summer heat and winter cold, is an important factor. The lush profusion of Florida mangrove swamps is overwhelming to someone familiar with the more restricted flora of a northern bog.

At a nursery or in catalogs, look for plants with the species name *lacustris* meaning "of lakes" or *palustris* signifying "of marshes." Those plants will be especially suitable for wet soil conditions.

Sunny Pond

The situation providing perhaps the widest range of possibilities is a sunny pond. Different zones can be observed as the ground slopes out from the shore. The boggy ground at the pond edge supports the growth of those plants which prefer copious amounts of moisture but not standing water over their crowns. Here you could grow astilbe with its fernlike foliage and feathery plumes of flowers in red, pink or white; the swamp milkweed *(Asclepias incarnata)* with pink flowers; turtlehead *(Chelone glabra, C. lyonii)* whose white or pink flowers look like the head of a turtle; the wildflower, Joe-Pye weed *(Eupatorium purpureum)* with its six-foot-high stems bearing rose-purple flowers in early autumn; hosta with bold foliage (yellow-leaved cultivars such as 'Piedmont Gold' do better with some shade); blue flag *(Iris versicolor),* a handsome native American iris with leaves perhaps two-feet high; ligularia *(Ligularia dentata)*—especially the cultivars 'Desdemona' and 'Othello'—with large leaves flushed purple beneath and branching heads of orange daisylike flowers in summer. One of the most handsome late-summer flowers is the velvety red cardinal flower *Lobelia cardinalis* and the blue-flowered *L. syphilitica.* Each reaches about two-and-a-half to three-feet tall. *Lysimachia, L. punctata* can be quite invasive, as can the lovely white gooseneck loosestrife *(L. clethroides).* One way to deal with this spreading tendency, especially in a naturalized setting, is to plant several spreading plants together and let them mix. I have combined the gooseneck loosestrife with *Monarda* 'Adam's Red,' a plant in the mint family. The crisp red and white combination pleases me very much. Like all mints, bee-balm prefers a wet soil where it can spread far and wide. The flowers remind me of an

A shady pond is bordered by several varieties of ferns. They also form a carpet on the shady floor under the trees.

A dammed stream introduces drama to this setting. A row of azaleas blooms against this backdrop.

exploding firecracker. Colors include: red ('Adam's Red', 'Cambridge Scarlet'), pink ('Croftway Pink') and purple ('Violet Queen'). The purple varieties seem to do better with a somewhat drier soil.

Shaded Pond

If the pond bank is shaded, a couple of these plants are still useful. Hosta and astilbe will grow quite nicely in light to medium shade. Of course, one group of plants commonly found in damp

A shaded pond is dotted with water lilies and bordered by iris, rhododendrons and ferns.

shady places is ferns. Their wonderful lacy texture provides such an excellent contrast for bolder foliage (such as hostas) that their lack of flowers doesn't matter. The cinnamon, royal and interrupted ferns are tall—three feet or more. They will grow on hummocks in water. The Virginia chain fern, *Woodwardia virginiana,* is another choice. Sensitive fern, *Onoclea sensibilis,* is tender to frost and turns a soft yellow in early autumn. The beadlike sticks of its spore cases are interesting even in winter.

Prominent foliage can be introduced with the rodgersias. While they will grow in full sun, I find their appearance by late summer a little tired and somewhat faded. They are much better in light shade, especially in warmer, more Southern gardens. The plants grow three-to four-feet tall and have flower spikes similar to astilbe, in white or pink.

One familiar kitchen garden plant which makes a bold foliage statement is rhubarb. It is really a first-class perennial with coarse foliage and enormous panicles of tiny white flowers. A rich diet and wet soil will help develop tropical luxuriance.

Other plants liking damp to wet soil and sunny to lightly shaded conditions are the many candelabra primroses with their flowers borne in extravagant tiers; forget-me-nots with their dainty blue flowers, and marsh marigold, *Caltha palustris,* whose bright golden flowers are among the earliest in the wet garden.

Emergent plants are found with their roots in shallow water and most of their foliage above water, generally in sunny sites. One familiar example is cattail, with its attractive irislike leaves. Similar in foliage is the sweet flag, *Acorus calamus.* The leaves are a fresher, more yellow-green and the flower is insignificant. Still with the handsome swordlike form is a true iris, the yellow flag, *Iris pseudacorus.* A European native, it has become naturalized and can be found growing wild. There is an attractive form with variegated foliage. Another good iris is the Japanese *Iris lacustris,* with deep blue-violet flowers. A good shallow water plant is pickerel weed, *Pontederia cordata.* The elongated heart-shaped leaves grow to two-feet tall. The flowers' spikes in late summer are a soft blue. Common arrowhead, *Sagittaria* sp., has, as its name suggests, arrowhead-shaped foliage. The flowers are white. This is an invasive plant and needs to be kept under control.

Deep quiet water is the perfect location for the hardy water lilies. Open in the daytime, their exquisite flowers in white, yellow or pink float on the surface with the rounded leaves two-to-three feet above the mucky pond floor. Be careful not to over-plant as vigorous cultivars can cover eight square feet. They need at least six hours of sunshine and space to spread. If the water is too deep or too cool (a result of shade or movement) the water lilies will not do well. Another hardy deep water plant is the yellow lotus, *Nuphar* sp. Do not confuse this genus with the Egyptian lotus, which is pink or white-flowered, and tender. *Nuphar* will grow in places water lilies cannot, in even deeper water (to as much as six feet), in light shade and in sluggish streams.

There are woody plants for wet soil too; shrubs such as pussy willow, red twig dogwood *(Cornus sibirica),* button bush *(Cephelanthus occidentalis),* swamp azalea *(Rhododendron viscosum),* sweet pepperbush *(Clethra alnifolia),* and swamp rose *(Rosa palustris).*

It is enough of a plant palette to coax gardeners into creating a pond or a bog, just to have a suitable habitat for these interesting and attractive plants. ✣

Trees and lacy ferns border a natural-looking pond.

Houseplants for Every Windowsill

Photo by Roche

Glass shelves create space for a variety of houseplants in a sunny window.

Tovah Martin

Gardeners like to share responsibility. In the outdoor garden the burden of duty is divided with Mother Nature. And, similarly, if a favorite houseplant suddenly perishes, indoor gardeners are apt to point the accusatory finger at the environment. They complain that their home is either too dry, too damp, too dark, too bright, too cold or too hot for houseplants.

Your house may not be the ideal environment for growing all tropical plants, but in most cases, there is a houseplant for every situation. If you cannot grow plants in your window, you are simply choosing the wrong plant.

Rather than taking my word for it—try finding the correct plant for your problem spot. If you water, groom and feed the plant, it should thrive.

Too Dry

Many modern homes are so efficiently heated and insulated during the winter that they are actually drier than the Sahara Desert. One solution might be to humidify. However, if you prefer not to do so, there are plants that will enjoy the dry atmosphere.

In a sunny window, you might try growing cacti and succulents. They have evolved specifically to deal with arid climates. They come in all shapes, sizes and forms from the infamous spiny ones to soft, woolly old-men cacti *(Cephalocereus senilis).* Kalanchoes are excellent blossoming succulents for a sunny window, and they can endure temperatures ranging from 40° to 70°F.

Most cacti and succulents prefer southern windows, and so it is not quite so easy to find candidates for arid east or west windows, but it can be done. You might try a Christmas, Easter

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Photo by George Taloumis

Geraniums of uniform size provide color and interest in a window that receives a great deal of sun.

or Thanksgiving cactus for an awesome annual display. Zonal-leaved pelargoniums (commonly called geraniums) will also tolerate a dry atmosphere. Begonias generally prefer humidity, but you might try *Begonia venosa* or *B. floccifera* as both thrive in desertlike conditions.

In a dry but shady window, try a cast iron plant *(Aspidistra elatior),* a peace-lily *(Spathiphyllum clevelandii)* or any member of the popular *Tradescantia* genus.

Too Damp

Dampness is not a problem for plants. Tropical plants thrive in damp environments. You can pick and choose among a vast array of houseplants to fill this niche. However, dampness can lead to fungal problems such as mildew and botrytis. Good air circulation helps prevent infestations of disease.

Too Dark

I admit north-facing windows can be a problem for those gardeners who want flowers. But there are many interesting foliage plants that can grace a shady, north-facing window. Try dracaenas, crotons, ivies and philodendrons. Ferns are excellent choices for north windows. Bear in mind, however, that ferns tend to require a humid environment.

If you want to try something a little different, grow a *Ledebouria socialis* on your shady sill. Its mottled, succulent leaves sprout from plump bulbs while tiny pink flowers appear in spring or summer. Or, try growing *Impatiens;* they provide a much-needed spark of color in shady east or west windows.

A sun porch that receives moderate light becomes the display area for a collection of begonias and geraniums.

Photo by Roche

Too Bright

If too much light is your problem, consider yourself fortunate. Most sunny windows are perfect for flowering plants. You can pick and choose between such gems as bougainvilleas, mandevillas, medinellas, allamandas and clerodendrums—to name only a few of the many possibilities open to you.

One word of caution: at certain seasons of the year, the sun may burn plants. It may be necessary to partially draw the blinds in summer to prevent the sun's rays from falling directly on and burning the houseplants' foliage. Or, you might move your plants a few feet back from the window in summer. Even the plants which can endure the sun's direct rays (such as succulents) will scorch if the leaves touch the panes.

Corner windows fitted with glass shelves contain a collection of begonias with ivies added in the center.

Photo by by Roche

Photo by George Taloumis

Hoya, jade plants and several peperomias all require a sunny window.

Too Cold

Some plants like cold. Acacias, *Hermannia verticillata* (honey bells), camellias, *Gelsemium sempervirens* (Carolina jasmine) and *Jasminum polyanthum* (winter-blooming jasmine) are just a few plants that require low temperature to set their flower buds. If you have a barely heated porch or vestibule, you might try filling it with a few of these stalwart cold-lovers.

However, steer away from tropicals such as begonias in locations where temperatures drop below 60 °F. When in doubt, check the plant's appearance for symptoms of cold distress. If the foliage becomes brittle, turns reddish, yellows or begins to drop, the location is probably too cold. Bud drop, especially on orchids, is another indication that the plant is getting "cold feet."

It often helps to move a plant a foot or two away from a chilly sill. The temperatures are generally warmer toward the center of the room, especially if your houseplant is in an alcove or bay window. Drawing the shades or curtains at nightfall also retains the heat.

Too Hot

Most houseplants can endure temperatures up to 120 °F without showing any ill-effects. Heat in itself is rarely a problem, and a fan is usually sufficient to keep the air from becoming "stifling". However, in a sunny, hot window plants can easily scorch. For suggestions about dealing with a sunny location, see "Too Bright."

So, no more excuses. Virtually any window can hold houseplants, and no self-respecting gardener should be without plants in the home.

A stairway window offers an unusual opportunity to display plants. Shown here is a collection of begonias.

Photo by Roche

Herbs for Every Place

Sal Gilbertie

Herbs are a blessing and I am doubly blessed in being an herb grower. I am thrice blessed when a customer comes into our herb center and says, "I have a hot dry spot with sandy soil" for I know herbs will make this person happy.

My dad was a cut flower grower in the 30s and 40s. After World War II, he diversified into potted holiday plants and later, bedding plants.

When we first began growing a few herbs in 1959, I naturally treated them as the crops my father had taught me to grow, being especially generous with water, rich soils and fertilizers. Most of the herbs were not very happy.

As I began to experiment and study their culture, I learned more and more that herbs were not very demanding. Actually, they seemed to thrive on neglect.

Many herbs will grow in pots which can be placed close to the kitchen door for snipping. Shown here is sweet basil.

Photo by George Taloumis

Gray santolina lends color and texture in the border along the brick edging. This herb is used traditionally as a border edging plant.

Several years ago at a horticultural trade show, we had a display of our herb plants. A prestigious Long Island grower who has a wonderful reputation for his flowering crops, walked past our booth. He waved his arm in a frustrated gesture and said, "You can have those blankity-blank herbs, they're nothing but trouble!" I just smiled and hoped he would always feel that way, because if he ever grew them sucessfully, he would be considerable competition for us.

Adelma Simmons, of Caprilands Herb Farm, often tells the story of how she started her herb business. She tells of a drought condition that existed at their farm in Coventry for two years and after the drought was over, "the herbs were the only plants that survived." Now that is not to say that herbs require no attention whatsoever, but they certainly need far less than most plants.

Herbs are by definition "soft-stemmed plants" and anyone espoused to botany knows that soft-stemmed plants are more susceptible to fungus problems than hard-stemmed plants. Fungus needs three conditions to grow—darkness, wetness and stagnant air. Herbs thrive in the exact opposite conditions.

That problem sunny, sandy bank where you never can get anything to grow is the ideal spot for a perennial herb garden. Hot sun, air circulation, and well-drained soils make herbs very happy.

In preparing any area for herbs, the primary consideration is the pH factor of the soil. Most herbs like a relatively neutral soil bed, so be sure to do a soil test and make the necessary adjustments to bring the pH to within the 6.5 to 7.0 range. Otherwise you will not get much growth.

I also add about 10 lbs of a dehydrated manure to every 20-25 square feet of planting area. Although herbs don't like a lot of fertilization, a bit of organic matter to get their root systems well established is a good idea, especially in a sandy soil.

Most perennial herbs require about 18″ to 24″ in spacing, so plan your planting area with that in mind.

More and more landscape designers and architects now recognize herbs as plants which offer attractive accents in addition to their culinary, fragrant and decorative uses.

Some of the more common perennial herbs which are readily available and which do extremely well in hot, dry, well-drained areas

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Salvia officinalis aurea, *golden sage, is a highly decorative sage with green leaves edged with gold. It makes a good accent plant.*

are the thymes, sages, santolinas, and lavenders. There are enough subspecies in the thymes and sages alone to plant any sizable area quite handsomely without much repetition in texture or color, but in the interest of space and time, I would like to briefly discuss six subspecies of each of the above varieties.

THYMES:

My favorite thyme is Silver Thyme—*Thymus vulgaris* 'Argenteus'. A perennial shrublike thyme, growing to about eight inches, with striking grey and cream variegated foliage and a strong thyme scent and flavor. In the period of chivalry, a lady often gave her knight a scarf embroidered with a bee over a sprig of thyme, as thyme was a symbol of courage and activity.

Other attractive thymes for the garden are: Golden Lemon Thyme—*Thymus* x *citriodorus* 'Aureus' which has bushy, upright growth, with brightly variegated, golden foliage. It is extremely decorative and intensely lemon-scented.

Doone Valley Thyme—*Thymus* x *citriodorus* 'Aureus' is a creeping, low-growing thyme, with dark green foliage variegated with gold. A very striking accent plant in the rock garden or in the herb border. Its lavender flowers attract bees to the garden and thyme honey is considered a great delicacy.

Yellow Transparent Thyme—*Thymus vulgaris.* Its glowing yellow/green foliage grows in

Plants for Many Situations

Masses of bulbs fill large containers in the IBM building adding softness and color.

Photo by James Fanning

Photo by George Taloumis

Top Lobelia cardinalis, *cardinal flower, will grow in wet places adding a bright touch of color.*

Bottom *Rhododendrons thrive in the moist shady conditions bordering a fast moving stream.*

Photo by Gottscho-Schleisner

Top Yucca filamentosa *'Golden Sword' planted in a mixed border makes a bold statement.*

Bottom Artemesia stelleriana *grows in the sandy dunes of the Northeast where it is native. This plant is a natural for seashore gardens.*

Photo by Gary Koller

Azaleas and Primula sieboldi *enliven a shady garden in early spring.*

Photo by Judy Glattstein

Daisies and grasses intermingle within sight of Long Island's shore. Their mixture is pleasing.

Photo by Gary Koller

Rhododendron carolinianum *provides a dramatic backdrop in a cemetary. This rhododendron is small in stature.*

The native water lily, Nymphaea odorata *adds color and variety to small ponds.*

Photo by Gottscho-Schleisner

bushy mats and makes an excellent accent plant.

Orange Balsam Thyme has green/grey foliage with exquisite pale pink flowers and a pleasant citrus/thyme pungent scent and flavor.

Oregano flavored thyme—*Thymus vulgaris* var. is a small evergreen shrub with glossy, bright green leaves which are larger than those of other thymes. Its oregano flavor is so strong that the plant is sometimes sold as Italian oregano.

SAGES:

It is said that sage will thrive or wither depending on the prosperity of the owner's business. We are especially careful not to overwater our sages. The Chinese so valued sage tea that they traded four pounds of their tea for every one pound of sage tea from the Dutch. The essential oils from sage are said to suppress the odor of fish, and all sages, when in flower, attract bees, butterflies and hummingbirds to the garden.

Dwarf Sage—*Salvia officinalis* is a small leaved, compact form of grey sage, growing only eight to ten inches. It is definitely my choice over common grey sage which can sometimes become too large a shrub to be manageable in the average size garden.

Golden Sage—*Salvia officinalis aurea* is a highly decorative sage with green leaves edged with gold. It is a compact, dense grower, about 10 inches high, but can easily spread to 24 inches around. It can make a great accent or, alternatively, be used as a border plant.

Purple Sage—*Salvia officinalis purpurea* has stunning dark purple foliage and a growth pattern similar to golden sage. Also like golden sage, it does not flower in the garden, but its striking leaf colors more than compensate.

Tricolor Sage—*Salvia officinalis* is an extremely attractive sage with variegated leaves of purple, green and cream. Its leaf size and growth habit are about one third less than that of the golden and purple sages, and it often flowers in the garden, although its seeds are sterile. Tricolor sage has a neat growth habit and can be used quite effectively as an accent plant or in a border.

Nemorosa Sage—*Salvia nemorosa* is a close relative to meadow sage, but much more

Lavandula angustifolia *thrives in light soil which is slightly alkaline and has good drainage.*

Photo by Elvin McDonald

Photo by Elvin McDonald

Here lavender invites closer inspection by a passerby. There are many varieties from which to choose. The blossoms are used in potpourri.

manageable in the garden. It also does not self-sow, saving you from the task of weeding out unwanted volunteers each spring. *S. nemorosa* has large pointed dark green leaves and tall erect spikes of lavender blooms reaching 18 to 24 inches. It makes a great cut flower and has a strong sage aroma.

Cleveland Sage—*Salvia clevelandii* is the sweetest smelling of all the sages. Its broad leaves are grey and hairy and it produces attractive blue 18-inch flower spikes in mid-June.

SANTOLINAS:

The early missionaries in California likened santolina to the saints for its durability in dry, poor conditions. I think it is a saintly plant because it repels all forms of insects from the garden. Traditionally used as a border hedging plant for formal herb gardens, it can be trimmed to any shape, but when left to grow into bush form, it becomes a perfect perennial shrub with yellow button flowers in mid-season. No legitimate herb garden should be without santolina. Its two foliage colors are dark emerald green and silver grey.

The two principal green varieties are *S. virens* and *S. ericoides.*

S. virens grows to 15 inches and has lacy, very aromatic foliage. *S. virens* has large yellow bud-like flowers about the size of a penny, whereas its cousin *S. ericoides* has flowers only the size of a dime. The foliage of *S. ericoides* is also much denser, more compact, and almost knobby. *S. ericoides* is easier to trim for a particular shape whereas *S. virens* makes better flowering accent plants.

The three principal grey santolinas are the common *S. chamaecyparissus* often referred to as lavender cotton; *S. neapolitana* and *S. pinnata.*

The common variety is the traditional hedge or edging plant in formal knot gardens. Its foliage is dense and compact and is easily shaped.

S. neapolitana has a much more lacy foliage. It is the lightest and most graceful of all the santolinas and gives almost a "ghostly" appearance in the garden at dawn and dusk. Use this unusual santolina wherever a feathery accent is needed for color or texture.

S. pinnata is the dwarf of all the grey santolinas. The growth habit is similar to its green relative *S. ericoides* and should be treated the same in the garden. An alternating planting pattern with *S. ericoides* makes for a most interesting effect as a border when neatly trimmed.

LAVENDERS:

The "English" lavenders, *Lavandula angustifolia* varieties, thrive in light soil which is slightly alkaline and has good drainage. Their fresh, clear scent make them a symbol of cleanliness, purity and virtue. Churches are decorated with lavender on St. Barnabas Day and midsummer to drive away evil spirits. They also will drive away insects and cats from the garden.

There are new subspecies of English lavender popping up every year and I get dizzy trying to keep up. They are all variations of the old *Lavandula angustifolia* subspecies *angustifolia* which is a grey foliage hardy shrub growing to 24 inches with lavender spike blooms. It is the largest shrub of all the *L. angustifolia* varieties and not the neatest grower, but probably the most prolific bloomer.

L.a. 'Munstead', named for Gertrude Jekyll's garden is the earliest blooming English lavender with lavender blue flowers. It only grows to 15 inches and is easily managed.

Lavender 'Grey Lady' is a more recently introduced cultivar similar to 'Munstead,' but an even neater grower with bluer flowers.

Lavender 'Hidcote' is the darkest flowering English lavender and probably the blossom most commonly preferred in potpourri making. It makes the most stunning show in the garden when planted in clusters about 18 inches apart. 'Hidcote' grows to the same proportions as 'Munstead' and 'Grey Lady'.

Lavender 'Rosea' has unique pink blossoms and is the neatest small shrub of all. This is my favorite for the garden, even though the blossom is not the traditional color which we usually expect for lavender.

There are many more wonderful varieties of herbs which would also do well for you. Lamb's ears *(Stachys)*, pussy-toes *(Antennaria)*, the winter savories *(Satureja)* and rues and artemisias, just to mention a few.

So you can see that a hot, dry sandy problem spot can easily be turned into a wonderful attractive herb garden which requires little attention but gives so much pleasure. ✣

Variegated sage grows between the bricks in a small garden. The leaves are textured and the plant has nice form.

WHEN THE WELL RUNS DRY...

Eliot Tozer

As aquifers around the country subside, and surface water becomes polluted, a shortage of water for gardens becomes a real possibility. Indeed, in a recent survey by the National Gardening Association, 16 percent of gardeners said that "too little water" was their major gardening problem. If, in addition, an area receives less than normal rainfall during the growing season, plants will almost certainly suffer and gardeners will have to come to their rescue. What can you do?

First, you can adopt some of the techniques used by plants that have adapted to life in arid regions (see box). In general, this means maximizing the amount of water that reaches plant roots and helping plants conserve what water is available. Second, you can select plants and shrubs that normally require very little water to survive and flourish.

The key to good plant growth is thorough preparation of the soil. Before dropping the first seed or digging a planting hole, add plenty of organic material to the soil—peat moss, compost, or well rotted manure. And dig it in deep. This will hold moisture in the soil until plant roots can take it up, and will also allow oxygen to reach the roots. What's more, prepared soil encourages deep rooting, a reaching down to levels where soil moisture does not evaporate so readily.

If you like to test new ideas, try digging in a few grams of "Water Grabber," a synthesized

Conserve water by trickle irrigation.

The old-fashioned rain barrel saves water from the roof and drain spouts.

Photo by Elvin McDonald

Eliot Tozer is a free-lance writer and has had a garden in Rockland County, New York for 40 years.

Areas which receive little rainfall are perfectly suited to cacti and succulents which have adapted to such conditions. This garden is in Palm Beach.

Photo by Elvin McDonald

Watering with a hose in hand is not the most efficient way to get the job done. Soaker hoses work better.

polymer used by commercial greenhouses, which absorbs up to 500 times its weight in water to form a gel. Plant roots grow through the gel to draw water as needed.

Choose a location for your garden that will maximize the amount of water available to plants. Avoid steep slopes. Water tends to run off such slopes quickly, sometimes before enough of it can soak in. On the other hand, avoid locating the garden in low spots where water can collect; roots rot when exposed to standing water. A good gardener will try to provide moist but well-drained soil.

Watch for competition from trees, especially those whose roots lie close to the soil surface, such as maple and beech. Among the conifers, Canadian hemlock *(Tsuga canadensis)* will also compete for moisture.

Most gardeners don't know how to use a hose. Hoses were not designed to be used by tired commuters on a summer evening—a sprinkle here and a splash there. Attach the hose to an emitter or soaker that drips water onto the soil next to the plants. . . for as many hours as necessary. The rule of thumb is that flowers and vegetables need one inch of water per week to flourish. An inch of water will sustain most plants for about three weeks.

On the other hand, don't overwater. Continued soaking leaches out nutrients and carries them to levels where they are unavailable to plants.

Many desert plants survive by reducing their rate of transpiration (the loss of water from their leaves). You can help your plants do the same thing. Locate the spot where plants will get some high shade, especially in mid-afternoon when air temperatures are highest. Maples and beeches are out, but oaks are in. Of the smaller trees, birches and dogwoods will also provide adequate shade and compete minimally for moisture.

By placing your perennial border near a stone wall, you'll achieve good design and provide shelter from the winds which can also hasten evaporation from leaves. And nearby walls also provide shade.

To keep the soil—and your plants—cool, mulch to a depth of one and a half inches before the soil dries out. Sawdust is a good mulch because it will eventually break down, improving the friability of the soil. On the other hand, sawdust leaches out nitrogen which you will have to replace. Shredded oak leaves are better, although over the years they will increase the acidity of the soil. Perhaps the best mulches are straw, rotted hay, and pine needles.

So, to keep your garden going during dry spells, prepare the soil well, provide water, if possible, and conserve the available water.

On the other hand, you can ward off water problems by selecting drought-tolerant plants in the first place. Here are ten, all perennials, which will provide a long season of bloom yet require little watering.

Achillea filipendula, the fern-leaf yarrow, bears small yellow flower heads in clusters up to four inches across. Rich, moist soil will encourage weak growth.

Coreopsis verticillata, threadleaf coreopsis, bears small, yellow, daisylike flowers. Height: two feet.

Echinacea, coneflower, bears purple or white flowers with maroon centers, some of which may extend five inches in width.

Echinops, the globe thistle, produces globe-shaped metallic blue flowers above spiny foliage. Note that it spreads vigorously.

Gaillardia, the blanket flower, bears bright red flowers tipped with yellow. Blooms last much of the summer. Height: six inches.

Monarda didyma, bee balm or bergamot, produces white, purple, rose pink, or cerise flowers on plants that grow three feet high.

Papaver orientale, oriental poppy, resists the heat of mid-summer by going dormant—not an attractive sight—but the glory of its orange-red petals in early summer is adequate compensation.

Phlox paniculata, phlox, bears large dense panicles of one-inch flowers in white, pink, salmon, red or purple.

Tradescantia virginiana, spiderwort, bears three-petalled flowers in blue, lavender, or white. If planted in rich soil, it may become a pest. Height: two feet.

Helping plants survive dry periods requires extra care but you may take some comfort in the knowledge that during drought, plants are less vulnerable to disease.

A planting of sempervivums in a California garden requires good drainage and some water in summer.

Survival Mechanisms

Plants have developed many ways in which to survive and flourish in arid regions. Most involve minimizing water loss by keeping cool or reducing the rate of transpiration. A few plants collect and store water to use as needed. And some simply remain dormant until there's enough moisture in the soil to support growth.

Under the desert sun, the temperature inside leaves may rise dramatically, increasing the plant's need for water both physiologically and metabolically. The ocotillo *(Fouquieria splendens)* responds by dropping its leaves, sometimes as often as five times a year. The desert holly *(Atriplex hymenelytra)* changes its leaf size during the year—smaller in summer, larger in the cool season. Cacti, on the other hand, avoid the problem by having few leaves, their stems

Cacti have adapted to little water by having few leaves—their stems fulfill leaf functions and the spines reflect solar heat.

fulfilling leaf function. Their spines, which are modified leaves, help reflect solar radiation.

Photosynthesis, the process by which plants manufacture carbohydrates, requires water and carbon dioxide. Water rises from the roots through the xylem and carbon dioxide enters the leaves through the stomates—pores in the leaf surface. When the carbon dioxide level rises and the metabolism rate increases, the stomates close, shutting out carbon dioxide and reducing water loss. In another adaptation, the stomates open only at night when temperature is lower and humidity higher.

Photo by George Taloumis

Yucca filamentosa *will grow in much of North America. Once established most will take considerable drought.*

Photo by Gottscho-Schleisner

Arid region plants also tend to have fewer stomates, or stomates that are below the leaf surface, protected from moving air that can increase the rate of evaporation. Other plants are protected from evaporation loss by a cuticle, a waxy layer atop the epidermis.

The succulents, Cactaceae and Euphorbiaceae, have large, thin-walled cells so they can store water until needed. In addition, the roots of cacti lie close to the soil surface so they can catch rainwater more quickly.

Then there are the ephemerals, the smaller plants that play a waiting game, refusing to germinate until there is enough moisture to carry them through the germination-bloom-seed-dispersal cycle. Some have impermeable seed coats which cannot be penetrated until there is plenty of water in the soil. Others contain growth inhibitors which can be neutralized only by prolonged exposure to moisture.

And once these plants have germinated, they grow fast. *Boerrhavia repens* goes from seed to bloom to seed in ten days. Some ephemerals of the western American desert are said to complete their life cycles within a few hours, the blossoms surviving no more than two or three hours.

Plants for Sandy/Poor Soil Banks

Kathleen Nelson

One of the most difficult gardening sites is a steep bank. Where homes are built on hillsides, earthmovers often produce steep banks while constructing foundations and driveways, and grading. These steep banks may have little, if any topsoil, and may be irritating eyesores. Those in the sun might develop a tangle of brambles and weeds, while those in the shade, may remain as exposed subsoil with a spattering of thin unhealthy weeds.

Growing plants on steep banks is difficult. Many will not grow well because the soil is too dry, and without a thick cover of vegetation, erosion may be a serious problem. "Good" soil—soil that is fertile and has plenty of water-holding organic matter—may be moister than "poor" soil, but may still be too dry for many plants. Even if grass would grow, mowing would be difficult, making it almost impossible to keep down brambles and weeds.

Practical (erosion problems) and aesthetic considerations may make it necessary to do something with these banks. A "problem" bank may be removed by constructing terraces or

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Garden slope with junipers, Vinca *and ferns.*

retaining walls and by adding good soil. Although many beautiful gardens have been built in this way, they were the answer to "Where can I put a wonderful garden on my steep property?" rather than "What can I do with this problem place to make it acceptable?" When I was faced with three problem banks, I evaluated the sites, my resources, and my expectations, and then chose plants appropriate to all three. This method worked well for me, and I can recommend it as a basic approach.

1. Evaluating the site: I looked at the slope, assuming steeper meant drier. I examined the topsoil, since the thicker the topsoil, and the more incorporated organic matter such as peat and humus, the more moisture it would retain and the wider my choice of plants would be. I estimated the height of the bank, assuming that a bank 20-feet-high would probably be drier than a bank three-feet-high. I evaluated light exposure carefully, since many plants will grow in dry sunny locations, but few tolerate dry shade.

The first of my three banks is behind a garage in bright dappled shade. It is about seven-feet-high and forty-feet wide, ranges from steep to very steep, and has topsoil or organic matter. The soil is a sandy-gravely mix dug out of the hillside during excavation for the garage, then piled behind the garage to divert water. The second bank is about five-feet-high and forty five-feet wide, is quite steep, has dappled shade, and is close to, and visible from, the entrance to the house. Neither of these banks has erosion problems because the ground slopes down behind them. The third bank is similar to the first, although smaller and less steep, and differs from the others in that it is a continuation of the slope of the woodland and could easily erode.

2. Determining the resources available: I considered not only the time and money I was willing to spend on the sites, but also the materials and plants I had available. I was willing to spread some topsoil on my second bank, but had neither soil, compost, nor money that I was willing to use on the others. Again, only the second bank merited much in the way of time. I did have large quantities of promising plants available, including periwinkle *(Vinca minor),* tawny day lily *(Hemerocallis fulva),* goutweed *(Aegopodium podagraria* 'Variegatum'), confederate violet *(Viola papilionacea), Lamiastrum galeobdolon* 'Variegatum', Christmas fern *(Polystichum acrostichoides),* an unnamed hosta, *Alchemilla mollis,* two small mislabelled azaleas, obedient plant *(Physostegia virginiana),* perennial sweet pea *(Lathyrus latifolius),* and *Veronica chamaedrys.*

Photo by George Taloumis

Incline along steps is ankle-deep with pachysandra.

3. Examining expectations: I knew I couldn't expect lush thick gardens without a major expenditure of time and money, but assumed that I could cover the ground with attractive plants that require relatively little maintenance once established. Although in a sunny site a colorful flowering rock garden would be possible with appropriate plants and maintenance, I had shade, and my expectations were modest. For the first bank I hoped for enough coverage to keep brambles from growing with no other maintenance than a yearly light raking of fallen leaves. No beauty was expected. Since it was hard to imagine worse conditions, this bank was assigned the status of experimental bank, into which any promising leftovers from my perennial nursery could be planted to see if they might

Periwinkle (Vinca minor) *is an evergreen ground cover hardy on this dry shady bank area.*

survive. For the second bank, which was close to the house and visible all year, I had much higher expectations. I wanted at the very least an evergreen ground cover, and hoped for spring flowers before the main garden beds began their display. The third bank was visible but not particularly noticeable from the house; I would settle for erosion control and a low ground cover—preferably evergreen—that wouldn't block the view into the woods.

4. Choosing plants appropriate to the site: Because the conditions were so unfriendly, I knew that if I was overly optimistic in my choice of plants they would be sure to die, and my time and plants would have been wasted. I wanted plants that could tolerate very dry infertile soil, with spreading roots that would anchor both the plants and the soil in place, and spreading foliage that would cover the soil and prevent weed seeds from sprouting. Plants spreading by rhizomes or stolons would be desirable. Since failures were likely, plants available in large quantities at little or no cost were preferred—a time to accept those invasive plants friends offer by the bushel. If paying for plants, I would try just a few to see if they prospered. Attractiveness was essential, evergreen foliage would be nice, and the plants must tolerate the available light and require little maintenance. A tall order.

I looked at banks everywhere—in the woods, along the roadside, on friends' property, in display gardens at nurseries and botanical gardens. If I had had sun, I would have considered the kind of plants used in the successful no-maintenance plantings on the banks of superhighways. If any plants had been already growing on the banks, I would have examined them closely to see if they could be used. I looked in old and new books about perennials, rock gardens, low-maintenance plants, ground covers, wildflowers, and shrubs, and read lists of plants recommended for dry soil, dry shade, banks, and sandy soil. I considered the plants growing on my property that seemed to grow anywhere or be too vigorous to be allowed to grow anywhere choice. Invasive plants began to look good.

5. Preparation of site: I removed existing weeds, raked, and spread two inches of topsoil on the second bank, the one visible from the

house. It would probably have been better not to rake, as raking loosened the soil and some erosion followed. But I know now that the topsoil should have been dug in, because it, too, partly washed away, and if I had it to do over, I would have dug in as much peat as I could have afforded, especially in the shady site where an attractive final appearance was desired. If the banks had been subject to major erosion because of runoff from above, I would have dug channels along the top to divert water to the sides.

6. Planting: During cool rainy weeks in spring and early fall, I planted both potted and bare root plants as close together as the supply would allow, placing them flush with the surface of the slope. Next time I would consider making individual pockets which would catch the rain, or digging larger pockets filled with good soil, especially for any special plants, or as an alternative to improving the soil on an entire bank. If full sun had threatened to bake the plants during the first few days, I would have shaded them. I watered the banks as needed for a few weeks. I tried spreading a thin mulch of wood chips on the second bank, but it wasn't thick enough to prevent sprouting of the weed seeds in the topsoil (the two banks with no topsoil had no weeds), and some of the mulch washed away in a heavy rain. Next year I will try the stringy shredded bark mulch to see if it sticks better.

7. Results: Of the three banks—all planted about three years ago—the second is the most successful. It had more time, materials, and thought invested in it, and it has even been weeded twice. However it is drier than expected because of a couple of large maple trees that pull in every drop of water in the vicinity. The mainstay of this bank is the evergreen *Vinca minor,* which is covering slowly but surely. It is not a success yet, but I think it is worth the wait. Better soil preparation (i.e. lots of peat), periodic watering, more frequent weeding, and shredded bark mulch might have helped. A deep red-orange day lily and a large-leaved hosta may not be increasing very fast but are holding their own and look good. Christmas fern, found on steep banks in my woods, is doing the same, and three small shrubs—a *Spiraea japonica* 'Alpina', which is in the sunniest location, and two deciduous azaleas—are growing well. *Alchemilla mollis* had also been planted here, but it did not survive. Several kinds of bulbs, including daffodils, tulips, and *Scilla hispanica,* pop through the *Vinca* in spring and seem to be doing fine.

The third bank has only *Vinca minor* and the very fast growing and invasive *Lamiastrum galeobdolon* 'Variegatum', a low ground cover with variegated foliage that forms dense mats and is covered with yellow flowers in the spring. It is not growing with great speed on this

Phlox subulata, *moss pink, grows in profusion on a sunny dry bank.*

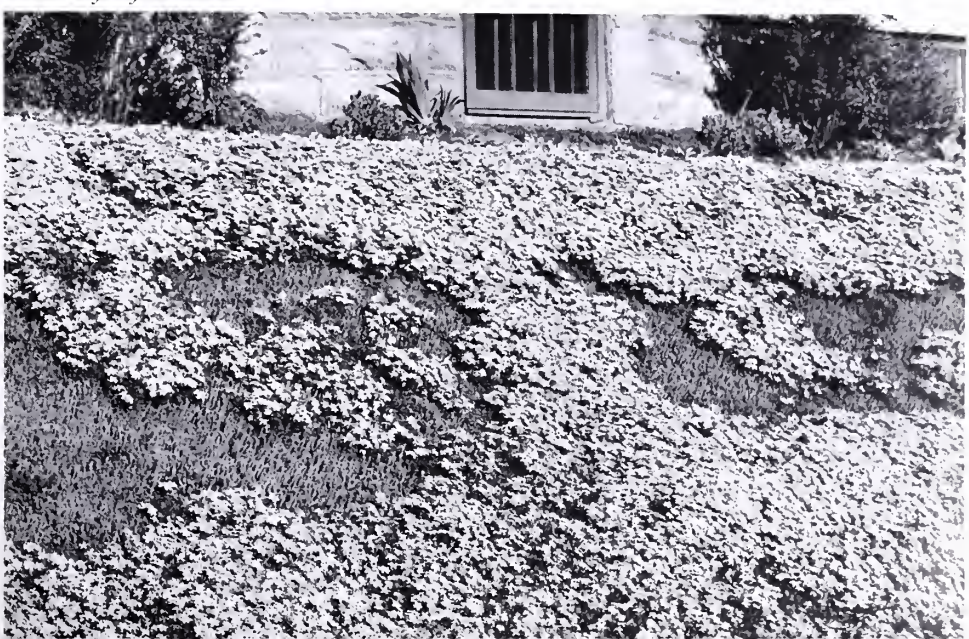

Photo by Gillsebo Schwisser

Photo by George Taloumis

Pachysandra grows thickly under pine trees.

bank, but is spreading faster than the *Vinca.* At this rate the ground covers can be expected to cover in a year or two, if I remember to pull up the strong little maple seedlings that are getting started.

The first, or experimental, bank, is the most interesting, showing both success and failure in really impossible conditions. The tawny daylily is surviving, but not spreading as yet. Goutweed is spreading and forms almost a complete cover, as does the lovely little confederate violet. In the sunniest area, obedient plant, *Amsonia tabernaemontana, Baptisia australis,* Maltese cross *(Lychnis chalcedonica),* and *Heliopsis* 'Summer Sun' are alive but not well. Perennial sweet pea is one of the most successful; it is the usual magenta, but seeds for a white form are also available. The plant I am most pleased with is the small mat-forming *Veronica chamaedrys.* It is six to twelve inches tall in my gardens and is covered with bright blue flowers in spring. It spreads very quickly in good soil, but fairly quickly in these awful conditions too. It is my favorite problem area plant: I use it around rocks in the lawn so we don't have to mow and on the edge of the driveway where the plow causes damage. It grows in sun or shade, in any soil, doesn't mind mowing, is a lovely cover for daffodils, and seems to be evergreen as well!

I look forward to more experiments. For shade I would like to try some more of the native ferns growing on the drier parts of my property. Perhaps sweet-fern *(Comptonia peregrina)* and the grassy *Carex pendula* would grow in dappled shade. For sun I would certainly use *Coreopsis verticillata,* a most glorious plant in

Vinca minor *fills in an otherwise unsightly bank area.*

Photo by George Taloumis

Goutweed (Aegopodium podagraria *'Variegatum') is a good choice for dry shady banks and may also thrive in sun.*

foliage or flower, and the prostate grey-green *Veronica pectinata* 'Rosea'. On a more experimental basis, I would love to try a patchwork of various-colored shrub potentillas, and maybe some of the herbaceous ones as well. Maybe the native bedstraw and some of the stronger Siberian irises would grow too. There are so many sun-loving plants that like poor dry soil that it would be hard to choose among them.

Some plants that may succeed on dry shady banks (many of these will also grow in sun):
Aegopodium podagraria 'Variegatum'—goutweed
Ajuga—bugleweed
Euonymus fortunei cvs. and *E.f. radicans*—winter creeper
Lamiastrum galeobdolon 'Variegatum'
Microbiota decussata—Siberian carpet cypress
Pachysandra, including variegated forms
Polypodium virginianum—common polypody fern
Polystichum acrostichoides—Christmas fern
Veronica chamaedrys—angel's eyes
Vinca minor—periwinkle
Viola papilionacea—confederate violet

Some of the many plants that will probably succeed on dry sunny banks (some will tolerate part shade):
Achillea—yarrow
Asclepias tuberosa—butterfly weed
Coreopsis, including *C. verticillata*
Coronilla varia—crown vetch
Echinacea purpurea—purple coneflower
Euphorbia myrsinites
Hemerocallis, especially more vigorous varieties—day lily
Hypericum calycinum—rose-of-sharon
Juniperus horizontalis—creeping juniper
Lathyrus latifolius—perennial sweet pea
Nepeta x *faassenii*—catmint
Oenothera tetragona—sundrop
Phlox subulata—moss pink
Sedum, including 'Autumn Joy'
Thymus—thyme
Verbascum chaixii—chaix mullein
Veronica pectinata 'Rosea'
Yucca, including variegated form

Woody Plants for Problem Places

Paul Young

A common question asked of nurserymen and experienced gardeners is: What tree or shrub should I plant? There are many choices for most situations, but all too often plants are selected for the wrong reasons.

Viburnums (here doublefile viburnum, Viburnum plicatum) *provide interest year-round and are resistant to disease and insects.*

Amelanchier canadensis *or shadblow, is a good candidate for slightly acid soils, shady sites.*

The first question to be answered is—Will the plants of choice grow and thrive in the location in question? The more difficult the growing site, the more research and judgment will be required.

After several candidates have been found that will grow in the sites under consideration, other factors can be evaluated. These include: ultimate size, flowers, fruit, autumn color, foliage color, form, texture, branch structure, bark patterns and resistance to insects and disease.

Always consider interesting features for more than one season of the year. Viburnums, for example, have flowers, attractive foliage, good fall color, interesting branching habits, berries that persist into winter and resistance to insects and disease. Here are four seasons of interest which certainly qualify this group of plants as more desirable.

Magnolia stellata *is an early-spring bloomer.*

Photo by George Taloumis

Paul R. Young is a practicing nurseryman in Connecticut as well as a landscape architect and arborist.

A popular city tree because of its tolerance to urban conditions is the star magnolia (Magnolia stellata).

Photo by George Taloumis

Heavy shade creates a habitat difficult for woody plants. Some species are more tolerant of shade than others. *Tsuga canadensis,* Canadian hemlock, is a good candidate for shady places. There are many cultivars to choose from. Rhododendrons are also good choices for shady sites. Another shrub, *Leucothoe axillaris* is dependable in the shade and has glossy foliage which turns to plum color in the winter.

Shady locations often have soils with a low pH. This fact also influences the choice of plants. There are many that prefer acid soils. *Amelanchier,* shadblow, blooms when the shad run. This attractive grey-barked tree prefers slightly acid soil. *Ilex* will also thrive under these conditions. There are many new cultivars to choose from; they are disease resistant, have glossy foliage and persistent berries—all attractive features. *Kalmia latifolia,* mountain laurel, is an evergreen shrub that is often overlooked. New cultivars now have red flowers or interesting markings—even some dwarf forms.

Dry, sandy soils provide another challenge. The cultivars of *Juniperus virginiana,* Eastern red cedar, offer a wide selection from which to choose.

Elaeagnus umbellata, autumn olive, thrives in poor sandy soil, has grey foliage, yellowish fruits, smooth grey bark and neat spreading habit. The birds feed on the berries during the winter months.

Where soils are wet, the pore spaces are filled with water forcing out life-giving oxygen. Most plants cannot survive under these conditions, but there are some to choose from. *Nyssa sylvatica,* pepperidge tree, tolerates swampy soil. This small tree has glorious autumn foliage of dark burnished bronze. It also has an interesting branching habit. Many hollies are also tolerant of soggy conditions, especially the deciduous holly, *Ilex verticillata.*

Areas near the coast present multiple problems of sand, salt and often, blazing sun. *Pinus nigra,* Austrian pine, will tolerate these conditions and add color and texture. An often overlooked hawthorn, *Crataegus phaenopyrum* (Washington thorn), is especially attractive in habit, bloom and fruit.

City situations add even more adverse conditions—tough plants are required here. Some candidates are *Ginkgo biloba,* maidenhair tree and its cultivars; *Picea pungens,* Colorado spruce; *Taxus* spp. Yews are very tolerant of city conditions as is *Magnolia stellata,* star magnolia.

Difficult sites require imaginative planning. It is a good idea to seek informed advice when reviewing plant lists and planting for year-round interest. ⚓

Japanese snowball, Viburnum plicatum, *can do well in shady sites.*

Gardening by the Sea

Judy Glattstein

Photo by George Taloumis

Astilbes, daylilies and dwarf dahlias dot this waterfront property.

Gardening books often make assumptions about general plant needs, such as good loamy soil, sufficient sunshine and adequate rainfall. And then they present plants suitable for these idealized conditions. Pity the poor seaside gardener, who cannot even dig a hole in the sand as the sides keep caving in. Do not despair and retire to the porch with a glass of lemonade to look at your plastic flowers, bleaching in the intense sunlight. Make your

Here a white picket fence defends a seaside garden from the encroaching beach.

This seaside garden overlooking Long Island Sound combines flowers and shrubs in a pleasing manner.

This Long Island property abuts sand dunes and plantings are therefore elevated from ground level to effect better soil control.

plant selections among the diverse array of plants that would rather grow along the coast, those which would rot and die if fed the over-rich diet and soggy conditions of the (typical) herbaceous perennial border.

Most important after plant selection, is getting plants off to a good start. So let us deal with this aspect first.

Avoid summer planting. The low rainfall and intense sunlight exacerbate the problems plants face when transplanted to a new location. Fall planting is often best for trees, shrubs and perennials. The cooler temperatures and autumn

rains help them adapt to their new location. The best conditions are those which occur on a cool, foggy, overcast day. If planting must be done on a sunny day, try to work late in the afternoon or early evening. The plant then has these few hours before daylight returns to acclimate. Use an anti-transpirant on trees and shrubs. It coats the leaves and reduces water loss, which is exactly what you are looking for. Perennials should be shaded for the first three or four days. Cover with a bushel basket, cardboard box, old window screens, or slatted cover. If possible, remove the covers at dusk and replace them first thing in the morning. The fogs and dew of night are beneficial.

Do not look for instant landscaping solutions. Smaller plants adapt, take hold and grow more quickly than large, specimen-size plants. Large plants have generally been "pushed" with extra fertilizer, copious water, and will be slow to adjust to a more spartan regime.

This seaside border is alive with delphiniums, peach-leaf canterbury bells, daylilies, regal lilies and violas.

Prepare the planting hole by lining the bottom with sheets of newspaper (no color sections please, the inks are often toxic). This will slow the movement of moisture. Mix some organic matter such as compost, aged manure or peat moss into the hole. If you use peat moss, wet it first by tearing a hole in a corner of the bag and letting a hose run at a slow trickle for several hours. Then let the bag sit overnight so that the dry brown peat can absorb the moisture. For spring planting, if you really want to give the plants a boost, mix up a concentrated solution of a liquid fertilizer and pour it into the bag in the evening. The peat moss will absorb nutrients along with the moisture, and hold it available for the plant's growth in the next few months. Do not do this in the autumn. It frequently causes the plants to make a growth spurt without sufficient time to harden before winter cold arrives.

For trees and shrubs I often line the planting hole with an old bushel basket, cardboard box or jute burlap. It is then simpler to put the prepared planting mix around the plant roots. The basket or box helps retain moisture, and stabilizes the plant against the wind—a frequent problem along the shore. Until the plant's roots have spread into the new site it can be shifted by strong on-shore/off-shore breezes. (Another reason to select smaller material. It will have less surface to act as a sail.) Both box and basket will decay over time. Do *not* use plastic bags, plastic burlap, or other rot-resistant materials.

Water well, and then mulch. Cobbles or smooth pebbles are appropriate in appearance to seaside gardens and are permanent. Organic material will need replenishment, adding humus to the soil as it decays.

By the sea, these smaller plants are better suited to take hold and grow quicker than larger plants.

Ivies, daylilies and astilbes create a seaside garden border.

Select plant material which you find attractive within the contraints of suitable growing conditions). I like the cool look of silver foliage and white flowers in brilliant sunshine. When choosing colors, I find the more intense, saturated tones more effective than pastels which often appear bleached.

Use woody plants to temper the effects of wind and salt. Use those most tolerant for a hedge row, and plant less adaptable varieties in their lee. A fence can also serve to temper the force of the wind and provide protection. A slatted fence will break the force of the wind and reduce its velocity better that a solid one.

Plants for Seaside Gardens in the Northeast

A standard for seaside gardens is the Japanese black pine, *Pinus thunbergii.* Its contorted shape is caused by salt damage to growing shoots from wind-borne spray. Another good needled evergreen is the red cedar, *Juniperus virginiana.* Its male and female flowers are found on different trees; the females have blue fruits which are attractive to many species of birds. A broad-leaved evergreen is the American holly, *Ilex opaca.* As with the juniper, sexes are separate and it is only the female plants which have the attractive red berries. A good deciduous tree, casting very light shade, is the black locust, *Robinia pseudoacacia.* The trusses of its pea-like white flowers are fragrant. A legume, this tree has nodules on the roots which contain nitrogen-fixing bacteria. It is, in effect, manufacturing its own fertilizer, a decided advantage in the poor nutrient levels associated with sandy soils.

There are more shrubs than trees suitable for ornamental use in coastal gardens. One of the best is tamarix. These shrubs are very salt and wind tolerant making them suitable for a windbreak. The flowers are loose fluffy pink panicles, and foliage is scanty. The salt spray rose, *Rosa rugosa,* is a Japanese plant happily adapted to American gardens. The wrinkled foliage, single magenta pink flowers, and large bright orange hips (fruits) are all attractive in the landscape. There are several named forms, with

Photo by George Taloumis

Beach plum, bayberry, cotoneasters and brooms form this shrub border of a seaside bank.

white or semidouble flowers. Shrubby junipers are also excellent choices because of their variety. *Juniperus horizontalis* for example is absolutely prostrate and forms a ground-hugging carpet while the Japanese garden juniper, *J. procumbens,* makes a rounded mound. Others such as *J. chinensis pfitzeriana,* are more upright.

Brooms are also legumes. Any of the *Cytisus* or *Genista* species—and their cultivars—is a good, though not long-lived choice for sandy soils in full sun. The foliage is much reduced and the stems are green, capable of photosynthesis. The pealike flowers are generally yellow to cream or white. Native shrubs such as inkberry, *Ilex glabra,* or bayberry, *Myrica pensylvanica,* are happy in a garden by the sea. The female plants bear the fruit, small black inconspicuous ones in the case of the holly, and grey-white in the bayberry. Their billowy moundlike form is a strong feature in the landscape.

In choosing perennials, be careful to select those suitable for the dry sunny conditions they will occupy. Legumes such as lupines and baptisia are excellent choices, along with coreopsis, gaillardia, seaside goldenrod, and the Montauk daisy, *Chrysanthemum nipponicum.* Butterfly weed, *Asclepias tuberosa,* with its bright orange flowers is attractive to butterflies. Achilleas, either the yellow *Achillea* 'Coronation Gold' or the red 'Fire King' are handsome too. Succulents, such as sedums or sempervivums are good for the hottest, driest locations.

Not too many annuals or summer bedding plants prefer the dry sandy soil that will be their lot. One choice is geraniums *(Pelargonium* cultivars*)* with their semisucculent nature. The California poppy, *Eschsholzia californica,* is another and can even be sown directly in place rather than transplanted. Another annual which can be treated in the same fashion is portulaca. An excellent choice is also nasturtium. Its vivid red, yellow or orange flowers and semivining stems seem to glow when placed against a backdrop of old weathered boards or silver-foliaged herbs.

By the sea.

Photo by Gottscho-Schleisner

One of the best plant groups for sunny dry locations is herbs. Many familiar herbs originated in the Mediterranean region, under dry conditions and impoverished soil. Artemisia, lavender, sage, santolina, *Stachys* (lamb's ears) thyme are all excellent aromatic foliage plants whose silver leaves provide an admirable foil for flowers in the garden.

Bulbs which like dry summer conditions include a number of alliums and ornamental onions such as chives. Most of the alliums have spherical flower heads in purple. They go dormant soon after blooming so it is best to combine them with a ground cover such as thyme. Little species tulips originated in Iran, Iraq and Turkey. They are more persistent, and even live longer in dry seaside gardens than in rich watered ones.

From trees and shrubs to perennials, bulbs, annuals and herbs there is a diversity of plant material to enhance your seaside garden.

Hybrid lilies are a colorful addition to this fenced-off garden.

Plant Selection Through Growing Seeds

Mary Cortina

Growing seeds has always been rewarding for the gardener. It is amazing how beautiful flowers germinate from the dustlike seed of begonias or the lead pellets of sweet peas.

Flowering plants fall into three categories: biennial, perennial and annual. Most biennials take two years to bloom. Some examples are foxgloves, sweet william and canterbury bells. To collect seeds from these plants, first tag the ones with flowers that have the best color and form, and label the information for future reference. Perennial seed can also be collected. Select from the best plants.

Young gardener tends the border of a seaside house. The planting is of mixed annuals—petunias, dahlias and alyssum.

Mary Cortina and her husband own Cortina Gardens in New Milford, Connecticut where they specialize in field-grown perennials and rock garden plants. She has been a gardener all her life.

Collected delphinium seed has given me some spectacular delphiniums. I am always looking for unusual features among my plants. I have selected from *Dianthus*, heucheras, *Iberis*, shasta daisies and many others, and have come up with some very lovely varieties, all from seed. To keep plants true to form, I take cuttings from them so the plants will all be the same.

Naturally you cannot keep every plant that germinates from seed, but by selecting the strongest and best looking plants you can sometimes discover some lovely and unusual flowers. Plant as many of a variety as space allows, let them bloom at their proper time, then select the best.

The search for plants that are somewhat different is endless but always rewarding. ✣

A sunny window provides the setting for a collection of scented geraniums.

Sources

Compiled by Victoria Jahn

While the following chart lists nurseries from all over the United States, it is by no means comprehensive. Many truly fine firms were omitted because we simply didn't have room. For more complete nursery listings, consult the *Plants & Gardens* handbooks on each specialty subject.

	Seashore	Houseplants	Herbs	Hardy/ Unusual Fruit	Tree & Shrub Seed	Roses	Native plants	Perennials	High Altitude
Abbey Garden									
The Banana Tree		★							
Bear Creek Nursery				○			○		
Kurt Bluemel								○	
Bluestone Perennials								○	
Bountiful Ridge Nurseries				★					
Caprilands Herb Farm			★						
Carroll Gardens						○		○	
Church's Greenhouse & Nursery	★								
Coastal Gardens & Nursery							○	★	
Cycadia		★							
Daystar									
Endangered Species		○							
Far North Gardens			○				★	★	
Forest Farm					★		○		
Glasshouse Works		★							
Glie Farms			★					○	
Greer Gardens									
High Altitude Gardens			○				★		★
Jerry Horne		★							
J.L. Hudson, Seedsman	○		○		★	○		★	○
International Growers Exchange		★	○				★	★	
Kester's Wild Game Food Nurseries							○		
Charles Klehm and Son Nursery								★	
Larner Seeds					★		★		
Lauray of Salisbury		★							
Lawyer Nursery	○			○	★	○	★		
Logee's Greenhouses		★	★					○	
Louisiana Nursery							○	○	
Lowe's Own Root Roses						★			

Victoria Jahn, Manager of Plant Information, Brooklyn Botanic Garden, is also Landscape Consultant for Rotch-Jones-Duff House and Garden Museum, New Bedford, MA.

KEY: ★ large selection
○ some, worthy of note

Alpines	Bulbs	Trees & Shrubs	Wildflowers	Xeric Plants	Cacti & Succulents	Bog	Grasses	Shade Plants	Comments
					○				
		○							emphasis on hardy and drought-resistant varieties
							★		
								○	
		○							
									beach grass
			○				○	★	good selection of hostas and hemerocallis
★		★							
		○			○		★		emphasis on bamboo and palms
			★	○					
					★				
							○		
		★							azaleas, rhododendrons and companion plants
○			★				○		
			○	○		○		○	hard-to-find seeds, extensive list
	★		★				○		also species orchids and bromeliads
						★			
								○	noted for hostas, peonies and daylilies
			★						Western and New England species
					★				begonias, gesneriads, orchids
		★	○	○					
					○				unusual herbs, begonias and tropicals
	★	★	○		○	○		★	over 300 magnolia cultivars, daylilies, iris

	Seashore	Houseplants	Herbs	Hardy/ Unusual Fruit	Tree & Shrub Seed	Roses	Native Plants	Perennials	High Altitude
McClure & Zimmerman									
Maryland Aquatic Nurseries								○	
Native Plants							★		
Nichols Garden Nursery			★					○	
Orchid Gardens	○						★	★	
Pacific Tree Farms		★		★			○		
Plants of the Southwest					★		★		
Prairie Moon Nursery					○		★	★	○
Prairie Nursery							★	○	
Putney Nursery			○				★	★	
Raintree Nursery				★			○		
Rocknoll Nursery								★	
Rock Spray Nursery	○							○	
Sheffield's Seed Co.					★		★		
Siskiyou Rare Plant Nursery							★	★	★
Anthony J. Skittone									
St. Lawrence Nurseries				★			○		
Thompson & Morgan			★		○		○	★	
Vick's Wildgardens							★		
Andre Viette Farm & Nursery								★	
Wayside Gardens	○		○			○		★	
We-Du Nurseries								★	
Windrift Prairie Shop							★	○	
Woodlanders							★	★	
Wyrttun Ward			★						
Yerba Buena Nursery	○						★		

Abbey Garden, 4620 Carpinteria Ave., Carpinteria, CA 93013.

The Banana Tree, 715 Northampton St., Easton, PA 18042.

Bear Creek Nursery, P.O. Box 411, Bear Creek Rd., Northport, WA 99157.

Kurt Bluemel, Inc., 2543 Hess Rd., Fallston, MD 21047.

Bluestone Perennials, 7211 Middle Ridge Rd., Madison, OH 44057.

Bountiful Ridge Nurseries, Princess Anne, MD 21853.

Caprilands Herb Farm, 534 Silver St., Coventry, CT 06238.

Carroll Gardens, 444 E. Main St., P.O. Box 310, Westminster, MD 21157.

Church's Greenhouse & Nursery, 522 Seashore Rd., Cape May, NJ 08204.

Coastal Gardens and Nursery, 4611 Socastee Blvd. Highway 707, Myrtle Beach, SC 29575.

Alpines	Bulbs	Trees & Shrubs	Wildflowers	Xeric Plants	Cacti & Succulents	Bog	Grasses	Shade Plants	Comments
	★								
						★	○		
		★	★	★			★		wholesale
			★			○		★	
		★		○					
				★			○		
		★	★	★			○	○	prairie plants
			★	★		★	★		
○			★					★	
									disease-resistant varieties; some native fruits
★		○						★	
				○					list identifies where seed was obtained (ie: Ithaca, NY)
★		★	★	★		○	○	○	
	★								
○			○	○		○	○	★	
			★			○		★	
			○			○	★	★	
	★	★	○				○	★	
				○		○		★	extensive list, unusual varieties
			★	★					
		★				○			
			★					★	
		★	★	★	○	○		○	California natives

Cycadia, 17337 Chase St., Northridge, CA 91325.

Daystar, Rt. 2, Box 250, Litchfield, ME 04350.

Endangered Species, P.O. Box 1830, Tustin, CA 92681.

Far North Gardens, 16785 Harrison, Livonia, MI 48154.

Forest Farm, 990 Tetherow Rd., Williams, OR 97544.

Glasshouse Works, Church St., Box 97, Stewart, OH 45778-0097.

Glie Farms, 1818 Bathgate Ave., Bronx, NY 10457.

Greer Gardens, 1280 Goodpasture Island Rd., Eugene, OR 97401.

High Altitude Gardens, P.O. Box 4238, Ketchum, ID 83340.

Jerry Horne, 10195 S.W. 70th St., Miami, FL 33173.

J.L. Hudson, Seedsman, P.O. Box 1058, Redwood City, CA 94064.

International Growers Exchange, P.O. Box 52248, Livonia, MI 48152.

Kester's Wild Game Food Nurseries, P.O. Box V, Omro, WI 54963.

Charles Klehm and Son Nursery, Route 3, Box 289, Champaign, IL 61821.

Larner Seeds, P.O. Box 11143, Palo Alto, CA 94306.

Lauray of Salisbury, Undermountain Rd., Route 41, Salisbury, CT 06068.

Lawyer Nursery, 950 Highway 200 West, Plains, MT 59859.

Logee's Greenhouses, 55 North St., Danielson, CT 06239.

Louisiana Nursery, Route 7, Box 43, Opelousas, LA 70570.

Lowe's Own Root Roses, 6 Sheffield Rd., Nashua, NH 03062.

McClure & Zimmerman, 1422 W. Thorndale, Chicago, IL 60660.

Maryland Aquatic Nurseries, 3218 Suffolk La., Fallston, MD 21047.

Native Plants Inc., 417 Wakara Way, Salt Lake City, UT 84108.

Nichols Garden Nursery, 1190 North Pacific Highway, Albany, OR 97321.

Orchid Gardens, 2232 139th Ave., N.W., Andover, MN 55304

Pacific Tree Farms, 4301 Lynwood Dr., Chula Vista, CA 92010.

Plants of the Southwest, 1821 Second St., Santa Fe, NM 87501

Prairie Moon Nursery, Route 3, Box 163, Winona, MN 55987.

Prairie Nursery, P.O. Box 365, Westfield, WI 53964.

Putney Nursery, Putney, VT 05346.

Raintree Nursery, 391 Butts Rd., Morton, WA 98356.

Rocknoll Nursery, 9210 U.S. 50, Hillsboro, OH 45133-8546.

Rock Spray Nursery, Box 689, Eastham, MA 02642.

Sheffield's Seed Co., 273 Route 34, Locke, NY 13092.

Siskiyou Rare Plant Nursery, 2825 Cumming Rd., Medford, OR 97501.

Anthony J. Skittone, 1415 Eucalyptus Dr., San Francisco, CA 94116.

St. Lawrence Nurseries, R.D. 2, Pottsdam, NY 13676.

Thompson & Morgan, P.O. Box 1308, Jackson, NJ 08527.

Vick's Wildgardens, Box 115, Gladwyne, PA 19035.

Andre Viette Farm & Nursery, Route 1, Box 16, Fishersville, VA 22939.

Wayside Gardens, Hodges, SC 29695-001.

We-Du Nurseries, Route 5, Box 724, Marion, NC 28752.

Windrift Prairie Shop, R.D. 2, Oregon, IL 61061.

Woodlanders, 1128 Colleton Ave., Aiken, SC 29801.

Wyrttun Ward, Beach St. RFD, West Wareham, MA 02576.

Yerba Buena Nursery, 19500 Skyline Blvd., Woodside, CA 94062.

Where-to-find-it Sourcebooks

ıdersen Horticultural Library's Source List of ants and Seeds compiled by Richard T. aacson. Lists over 30,000 plants and 200 ırseries. Available from Minnesota Landape Arboretum, Box 39, Chanhassen, MN 5317. Published in 1987; $29.95 postpaid.

ombined Rose List compiled by Beverly R. obson. Foreign and domestic sources for 000 varieties, including many old and ırd-to-find roses. Available from Beverly R. obson, 215 Harriman Road, Irvington, NY 0533. Updated annually. $10.00 postpaid.

ıe Gardener's Book of Sources by William ryant Logan. A generous potpourri of ırseries, books and societies all grouped ıder special interest categories. Published ı 1988 and available at $12.95 from enguin Books, 40 West 23rd Street, New ork, NY 10010.

ardening by Mail by Barbara J. Barton. ıdexes 1,000 nurseries by specialty. Wellrganized, comprehensive and updated nnually. The 1987 edition is $16.00 from usker Press, P.O. Box 1338, Sebastopol, CA 5473.

raham Center Seed and Nursery Directory by ary Fowler and Elaine Chiosso. Booklet overs nurseries which specialize in unusual r old-fashioned vegetables, herbs, fruits nd native plants. For ordering information ontact: Rural Advancement Fund, Box 029, Pittsboro, NC 27312.

ursery Source Manual, a handbook. Brookn Botanic Garden's 1982 handbook gives ources for 1,300 trees and shrubs, includng many unusual varieties. $4.75 postpaid rom *Plants & Gardens,* Brooklyn Botanic arden, 1000 Washington Avenue, Brookn, NY 11225.

ursery Sources, Native Plants and Wild lowers. Roughly 200 firms are indexed by pecialty and region. Compiled by and available from the New England Wild Flower Society, Garden in the Woods, Hemenway Road, Framingham, MA 01701. Current issue is $3.50 postpaid.

Sources of Native Seeds and Plants compiled and available from the Soil Conservation Society of America, 7515 Northeast Ankeny Road, Ankeny, IA 50021. Nearly 300 nurseries are listed by state and general stock (trees and shrubs, wildflower seed, native grass seed). $3.00 postpaid.

Bibliography

Brenda Weisman

Brenda Weisman is Director of Information Services at Brooklyn Botanic Garden.

The following list of books has been prepared for those who wish to read in depth on certain subjects. These publications are all in print.

In addition there are many books on regional gardening too numerous to list. Check your local library or botanic garden.

There are also many relevant books by such publishers as Houghton-Mifflin *The Taylor Guides; New York Times,* Joan Lee Faust, editor; Ortho; Sunset and Time-Life.

Some authors to check for in the library are: Ernesta D. Ballard, James Underwood Crockett, Thalassa Cruso, Marjorie Dietz, Charles Marden Fitch, Montague Free, Jack Kramer, Elvin McDonald, George Taloumis and Helen Van Pelt Wilson.

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A city garden in spring with tulips and narcissus pushing up through the ivy ground cover.

Photo by Gottscho-Schleisner

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Types & Styles, Guidelines for Care & Maintenance, Plants to Grow

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BROOKLYN BOTANIC GARDEN RECORD

Greenhouses & Garden Rooms

1988

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Garden Room
Cover photograph by Elvin McDonald

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foreword

Tovah Martin

For people who love plants, one of life's pleasures is to provide their collection with the perfect environment. Sometimes, ideal conditions are available outdoors. But, when this is not the case, gardeners turn to greenhouses and garden rooms to furnish the warmth, light and humidity that plants require.

Many gardeners dream of having a greenhouse. And that goal becomes increasingly easy to achieve as greenhouse technology advances and more systems appear on the market. Greenhouses come in all shapes and sizes. They can be added to the window of a city apartment or stand separate from the house. There is a greenhouse for every gardener.

Our goal in this handbook is to introduce you to the various types of greenhouses and garden rooms and to help you choose which is appropriate to your purposes. We have described some of the mechanical workings of a greenhouse so that your can heat, cool, ventilate and shade your structure efficiently. And, knowing that many of you are planning to grow a specific crop in your greenhouses, we have described greenhouses for cut flowers, orchids, winter-forced bulbs, and cool-loving plants. This handbook also presents ideas for plant maintenance in the greenhouse environment. Finally, because problems will occur, we have covered pest and disease management in the greenhouse.

A lean-to greenhouse located on a partially shady site receives enough light to grow a variety of houseplants, geraniums and many seedlings.

A Little Background— The Greenhouse's Roots

Tovah Martin

Greenhouses are not modern inventions. There is written evidence that the Romans fashioned transparent structures for the protection of rare, tender fruit off-season. Those buildings were called *specularia* and they were glazed with thin sheets of talc and mica. In addition, they were heated by amazingly sophisticated stove and flue systems that circulated warm air throughout the structure.

Although artificial environments for protecting plants against the elements have had many critics over the centuries, man has continued to build and to perfect glass structures throughout the ages. In the 17th century, *orangeries* came into vogue in Europe. These glass-sided buildings were constructed specifically to protect citrus, the fruit of kings, thus allowing royalty the luxury of enjoying juicy sweet fruit off-season. However, *orangeries* were heated either by primitive stoves that required constant attention or by steaming manure piles.

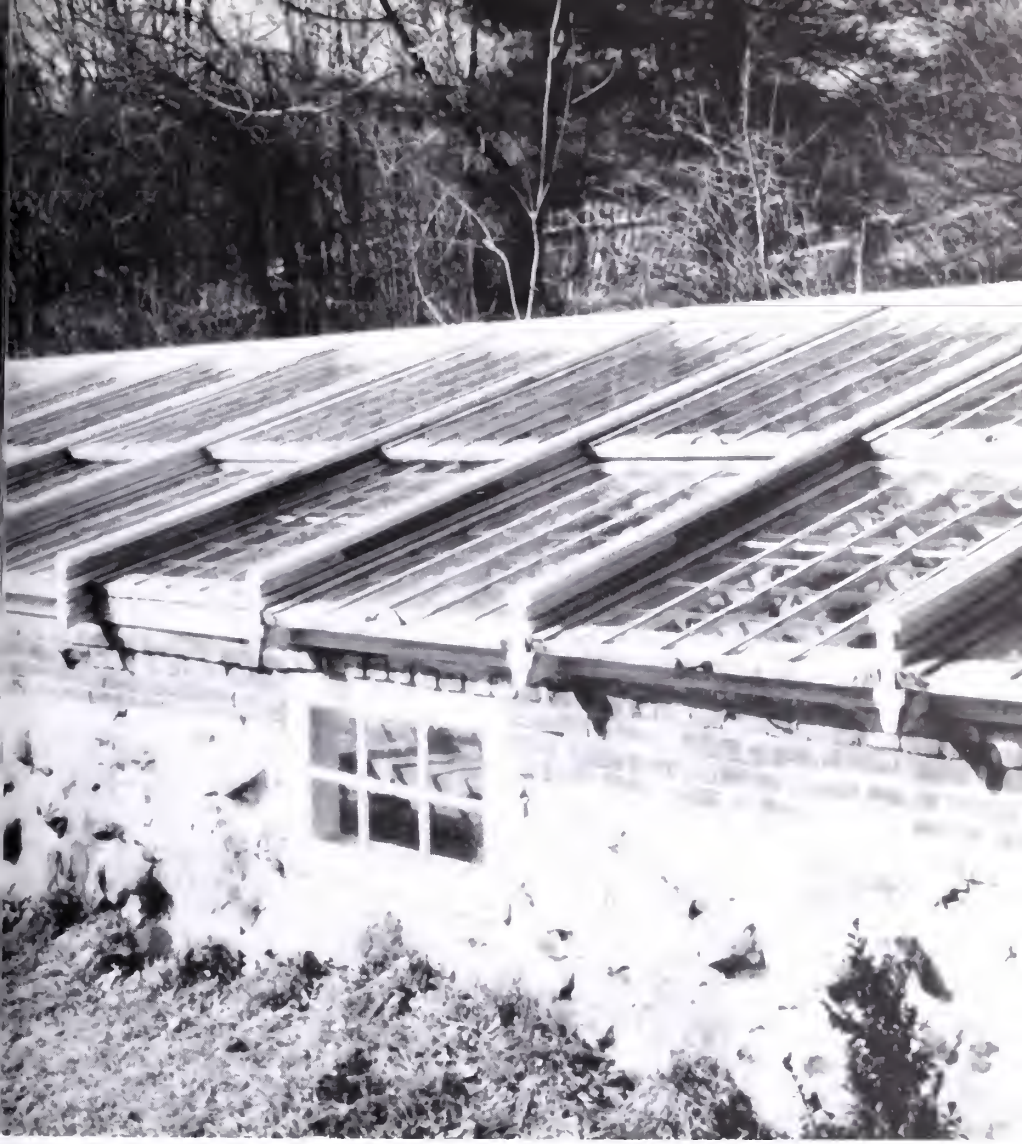
With the dawning of the 19th century, greenhouse technology took flight. In 1845 excise taxes on glass were lifted. Before long glass-making processes were revamped, making glass inexpensive to purchase, readily available and of good quality. At the same time tropical plants were arriving in Europe from the temperate regions of the globe. With those magnificent tropicals to protect, gardeners struggled to develop glass structures that were sufficiently sophisticated to shelter tropical plant life. They set to work studying slopes, calculating positions, as well as inventing efficient furnaces and piping systems. Greenhouse construction took a giant leap forward.

But greenhouses were expensive to con-

Photo by H. Light

This greenhouse dates from 1795-1800, but it was well into the late 1800's before greenhouse building became commonplace.

Tovah Martin, Danielson, CT is staff horticulturist at Logee's Greenhouses. She is a freelance writer, photographer and author of Once Upon a Windowsill *published by Timber Press, 1988.*



struct and maintain. That situation was not destined to change overnight. Finally, by the middle of the 19th century, prefabricated greenhouses appeared on the scene. They were common on the European market by the 1880s.

In North America, we have some unique environmental problems with which to contend: for one, a severer winter climate than in Great Britain. Throughout most of the 19th Century, we trailed behind Europe in the construction of greenhouses. Finally, Frederic A. Lord happened upon the scene. Lord built his first greenhouse in the frigid city of Buffalo in the mid-1850s and from then on he labored to perfect stoves that would maintain greenhouse temperatures despite sub-zero outdoor temperatures. Apparently, he was successful. By the 1870s, his greenhouse building business was so brisk that Lord took his son-in-law, William Burnham, into partnership.

We've come a long way since those early greenhouses and we undoubtedly have a good distance to travel until greenhouse technology has reached its pinnacle. However, we owe a debt of gratitute to the first gardener who decided that he must have fruit despite the weather outdoors. ⊠

Selecting a Hobby Greenhouse

John W. Bartok, Jr.

A hobby greenhouse will allow you to enjoy gardening when the weather outside is too cold for growing plants. When deciding on a greenhouse an important consideration is how it will be operated.

The season-extender greenhouse is used primarily to extend the growing season by a few weeks in the spring and fall. Garden vegetables and bedding plants can be started earlier in the spring and flowering plants kept in bloom later in the fall.

For year-round operation some supplemental heat is needed. If a cool greenhouse is operated to grow leafy vegetables or overwinter ornamental shrubs, it can be a small auxiliary heater. For most flowering plants a system capable of optimum temperatures is needed.

A greenhouse or sunspace attached to the house can be used as an extension of the living space or as a solar collector if designed properly. An orientation to the south is preferred. If operated as a greenhouse it has the advantages of convenient access and nearness to water and electricity.

Freestanding greenhouses are generally more expensive but allow greater flexibility than attached styles because they can be larger and located to receive more sunlight. Many different shapes are available.

All photos by John Bartok

A newly built sunspace is an extension of the house. The heat-retaining wall and southern exposure maximize solar heating.

John W. Bartok, Jr., Storrs, CT is an extension professor and extension agricultural engineer at the University of Connecticut. He is also a monthly columnist on greenhouse construction and maintenance for Horticulture *magazine and* Greenhouse Manager *and has authored or coauthored four books, the most recent being* Greenhouse Engineering.

Attached greenhouses can take advantage of easy access to water, electricity and heat. The space can be used for plants and/or added living space.

The pit greenhouse, built partially below ground, uses the earth to keep it cool during the summer and warm during the winter. Strong walls to withstand the soil pressure and adequate floor drains are needed.

Size

Usually available space and cost, more than need or desire, dictate greenhouse size. When choosing a size, ask yourself how you will use the greenhouse. Are you really an avid gardener that has the time to care for the plants. If you are only starting a few seedlings for the summer garden, perhaps a hotbed is a better choice.

A minimum size for a hobby greenhouse is 8′x12′ or 10′x10.′ This gives enough room for benches and a work aisle. Eave height of gable roof houses should be at least five and one-half feet and ridge height at least eight feet.

Frame and Foundation

Aluminum or galvanized metal frames are attractive and require little maintenance. To reduce heat loss some metal frames have thermal breaks. A wood frame is often the first choice of the do-it-yourselfer. Wood is easy to work with and costs less than other materials. Pressure-treated material should be used where it is in contact with the ground or for benches. It will last 25 years or more. Do not use wood treated with creosote or pentachlorophenol because it releases vapors harmful to plants.

Plans for wood frame hobby greenhouses are available from the Agricultural Extension Engineer at your state Land Grant University. If you own and like to use a few basic hand tools, you may want to purchase a greenhouse kit. All the materials for the structure except the foundation are usually included. The names of local greenhouse suppliers can be found in the phone book business pages.

All greenhouses should be anchored to a solid, level foundation. Concrete, concrete block or brick are commonly used. Pressure treated posts set 18 inches or more in soil or concrete make a simple, low-cost foundation for a wood frame greenhouse.

Several inches of gravel or pea stone should be used on the floor for drainage. Brick, flagstones or concrete make a good walkway.

Benches and Beds

Benches raise the plants to a convenient work-

ing height. A standard height is 30-32 inches. Side benches should be two to three feet wide and center benches may be as wide as six feet. Growing beds can be built as movable boxes or fixed permanently to the greenhouse floor. Frequently a ground-bed is located along the south sidewall to reduce shading of plants in the rest of the house. Pipes or wires above benches can hold hanging plants.

Glazing

Of primary importance in growing plants is the amount of light energy available for photosynthesis. This is especially true in northern latitudes during the winter when the sun angle is low and the daylength is short.

Glass is still the most common glazing for hobby greenhouses. Its clean appearance and transparency adapt well to today's homes. With larger panes available (up to four feet by seven feet) more light gets into the greenhouse. Low-cost tempered sliding-glass-door replacement panes make excellent glazing for custom built greenhouses. Bar caps and strip caulking material have reduced installation labor. The use of double wall tempered glass reduces heat loss by about one third. The additional cost of low iron glass is usually not cost effective even though light levels are increased by two to three percent.

Polycarbonate structured sheets are available in several thicknesses from four to 16 mm. Normally seven to eight millimeters is used for hobby greenhouses. To insure long weatherability and durability purchase a co-extruded or coated polycarbonate sheet. These sheets will yellow less than an untreated material. Polycarbonates also have less flammability and higher impact resistance to hail or vandalism than the acrylic materials. For example, a six millimeter sheet will take a blow from a 10 pound steel ball dropped seven feet without cracking.

Acrylic structured sheets are available in eight and 16 millimeters thick sheets. Although they've been in use in the U.S. for only 10 years, a similar single-skin material — plexiglas — has been around much longer. This material does not yellow with age. Plexiglas is used in place of curved pane glass and in areas that might be subject to breakage.

Improvements in film plastics are still coming out of manufacturers research centers. Increases in strength, clarity, life and energy conservation are recent developments. Because most films do not have as long a life as rigid glazings, they are not used as frequently for hobby greenhouses.

The stronger co-polymer plastics called "greenhouse plastics" will give good service for two to three years. These can now be purchased with an infrared radiation inhibitor that reduces the heat loss from inside the greenhouse by up to 20 percent on a clear night. Monsanto calls theirs "Cloud 9" and FVG America has named theirs "Sunsaver." Although the light transmission is the same as other greenhouse grade plastic films, the cloudy appearance diffuses the light.

Window Greenhouse

A window greenhouse is a good choice where you have limited space and time for gardening. A south facing window is best but windows facing east or west can also be used.

The window to which your greenhouse is attached must be the double hung casement type (opening up and down) or one that slides sideways because the plants must be accessible from the inside. Because the window greenhouse contains such a small volume of air, more attention to heating and cooling needs is required.

All types of greenhouses can give many hours of relaxation and enjoyment. The most common complaint is that it gets too small too quickly. ▩

Freestanding greenhouses allow greater flexibility than attached styles because they are larger and can be located to receive the most sunlight. Many styles are available.

Window Greenhouses

Photo by Roche

Apartment gardeners can have greenhouses, too. There are many sizes and styles of window units available.

Linda Yang

Apartment gardeners go to great lengths to keep their houseplants happy. This includes altering their homes to suit their plants. One major modification is a window greenhouse, which can also be an attractive extension to a room.

The idea for the first commercially produced window greenhouse is believed to have originated about 25 years ago when Cyrus D'Amato was preparing to display patio doors at the New York Flower Show. To make his glass products more appealing, he carved an opening in the wall of the display trailer and filled it with a "glass box" of plants.

He noticed that the visitors to the show were more intrigued with the box bursting with blooms than the storm doors he was trying to sell them. And so, the window greenhouse was born.

Mr. D'Amato's design was the inspiration for Lord & Burnham's Jiffy Window Greenhouse which has sold well over the years and has recently been revised to feature double insulated glass. The 17-inch-deep units are constructed of aluminum and can be purchased in varying widths (36" to 72") and heights (36" to 72"). With the option of obtaining additional shelves for the units, Lord & Burnham advertises that their window greenhouses provide plenty of room to grow.

It was to Lord & Burnham that Kurt Munkacsi turned when his dozens of cactus plants overgrew his windows. A New York City based

Linda Yang, New York, NY writes about gardening for the Home Section of The New York Times. *She is author of* The Terrace Gardener's Handbook *and is working on a second book about gardening in the city.*

ecording engineer and record producer, Mr. Munkacsi's involvement with houseplants began innocently enough when a friend gave him a tiny lithops. Fascinated by that succulent, he continued to buy them by the score. The growing space dwindled in the downtown loft that is his home and office and a window greenhouse seemed the way to grow. His succulent collection is now comfortably accommodated in an arid window greenhouse.

Pat Beadle, a production manager with a film company, bought her unit to provide a humid atmosphere for her scores of orchids, begonias and ferns. Her husband assumed that the greenhouse would ensure that her bulging collection would be confined to one place. But Mrs. Beadle has used her unit to propagate even more plants, distributing them to other sills. Her husband, accepting the inevitable, devised mesh screen doors that separate the greenhouse unit from the room and keep their cats from jumping into propagating trays.

Although these two city gardeners employ their window greenhouses to provide completely different climates, the unit they use is basically the same. And they both faced similar installation problems. The installation charges are usually extra, but while it's not impossible to "do it yourself," it's not so easy in the city. Lord & Burnham suggests that a local contractor be used to help with the work of following the instructions provided.

Projecting window greenhouse units are usually not a problem on city walls that are set back from the building line. But, if the unit is planned for an area where it will overhang the street, building department safety procedures must be followed. So it is best to check with your local authorities before you begin.

A typical installation for masonry buildings entails first fastening a wood frame to the outside walls with expansion shields and lag bolts. The greenhouse is then attached to this frame, completely surrounding the existing window, from which the sashes may then be removed.

For penthouse or brownstone residents, this may mean using a long ladder or scaffolding, or a cable from the roof to temporarily suspend the unit while it is being secured.

Mr. Munkacsi's situation was particularly challenging and his solution was logical and innovative. Since his loft is on a high floor and his window area is not accessible on the exterior from either below or above, he used a custom-sized unit that would fit through his window from inside the room. Friends in the stage construction industry fabricated a heavy aluminum frame that he used to replace the original wood window sashes. Working from indoors, he could then slide the greenhouse through the window opening and attach its sides directly to the inner faces of this new aluminum frame.

Both Mrs. Beadle and Mr. Munkacsi removed the original windows so their greenhouses open into the room and benefit from apartment heat. His houseplants require a dry environment, hers need humidity. Their window greenhouses have made it pleasurable for them to do just that.

Ken Munkacsi studies his cactus collection which is housed in a New York City window greenhouse.

Photo by Linda Yang

Portions of this article first appeared in the Home Section of The New York Times.

Photo by Roche

Guidelines for Building a Greenhouse

Linda Yang

In 1987 more than 10,000 hobbyists' greenhouses were built in the United States, according to Dr. Harold E. Gray, the executive director of the National Greenhouse Manufacturers' Association. The average cost of an 8-by-15-foot structure was $2,000 to $3,000; to make it a working greenhouse that figure must be multiplied two and a half times. "Less than a second car," Dr. Gray commented.

There are more than 100 greenhouse manufacturers nationwide, offering a wide variety of styles. The association has prepared a list of them, as well as guidelines on lighting, ventilation, siting and other considerations. These are available free from the association. Send a self-addressed, stamped envelope to P.O. Box 567, Pana, IL 62557.

A magazine, *Greenhouses for Living*, is devoted to the subject, with articles on questions like how to select a builder, and how to finance it. Issues cost $6.95 in bookstores and $8.00, postpaid, from 350 Fifth Avenue, Suite 6124, New York, NY 10001.

Every city has special code requirements concerning greenhouses. In New York, building permits are required, and people living in cooperatives must have permission from the building's board. Laminated safety glass or wire glass that will not shatter is mandatory. An architect or engineer is usually consulted for roof-top construction because of code requirements regarding snow load and wind shear. ⊠

This article first appeared in the Home Section of The New York Times, *Thursday, January 21, 1988.*

Not all greenhouses are made with glass. This simple structure is plastic covered. The type of greenhouse needed depends upon the plants to be grown within.

Garden Rooms for Everyone

Ogden Tanner

In recent years glass additions have become increasingly popular, not only as greenhouses for serious indoor gardening, but as rooms to live in, eat in, take baths in and almost everything else. In the pages of magazines, happy families are pictured using theirs in all sorts of mouth-watering ways: sunbathing in the dead of winter, breakfasting among potted palms, splashing merrily in hot tubs with wine glasses raised high, entertaining dinner guests by candlelight under a sky spangled with stars.

Call them sun rooms, solariums, garden rooms or whatever you like, these spaces differ from working greenhouses in one major respect: they are designed primarily for people, with the accent on comfort, outdoor views and the sun itself. While some decorative plants are usually part of the scene, they are supporting players, not the stars. Fortunately, there are many species whose basic needs for light, temperature and humidity do not conflict with those of human occupants.

Among other attractions, a prefabricated glass unit can be less expensive than a conventionally built addition, and can add at least its cost to the resale value of a house. Moreover, if properly designed, it can trap, store and distribute sun heat, sharing its warmth with the rest of a home and reducing household heating bills.

Ogden Tanner of New Canaan, Connecticut, is a former editor of the Time-Life Encyclopedia of Gardening and the author of Garden Rooms.

The ideal exposure for a garden room, like a greenhouse, is south for maximum winter sun. Southeast will provide welcome morning sunlight, and is a good choice for a breakfast room; a southwest exposure yields more afternoon sun and may provide a nice view of sunsets, but will require shading, especially in summer, against hot afternoon rays. Unlike a working greenhouse, a live-in glass addition can even be placed on the north side, though it will receive mostly indirect light and no solar heating, and will have to be furnished with plants that tolerate lower light intensities.

The most practical shape for the average sun room is a rectangle with its length along the side of the house measuring about one and-a-half to two times its projecting width—the greater the glass area facing south the more sun it will get, and the greater the wall area the sun room shares with the house, the greater the potential for an exchange of solar heat between the two.

Manufacturers' units, which are generally cheaper than custom-built designs, come in a variety of choices, from a glorified bay window three-feet deep and eight-feet long, which can serve as a modest enlargement of an existing room, to a two-story solarium

Philodendron selloum *makes a bold architectural statement in this garden room setting. Other plants include a* Cattleya *orchid, orange,* Asparagus densiflorus *and other orchids and foliage plants.*

10-feet deep and more than 50-feet long—big enough for an indoor swimming pool. A common tendency among budget-conscious homeowners is to order the smallest size they think suitable to their purposes, only to discover that the new space is used so much it doesn't seem big enough. Because of square-foot economies inherent in construction, installing a larger model can actually yield as much as 50 percent more space at only 25 percent more cost.

Units with wooden structural frames provide a substantial, natural-looking extension of a house, and can be stained or painted any color. Most manufacturers' models, however, are made of slimmer aluminum members, generally with dark bronze or white baked-enamel finishes that are virtually maintenance-free. The best units have secure seals against air and water leaks, thermal "breaks" to minimize conduction of heat (and cold) through the metal, and gutters to carry off condensation on the inside of the glass.

Rigid plastics can be used, particularly on roof sections and end walls, but for maximum light and views most sun rooms are enclosed in ordinary glass, which is highly transparent, scratchproof and durable. The annealed glass used today is strong enough to resist breakage under normal conditions, though many manufacturers recommend tempered or laminated glass, particularly for high-use areas and overhead glazing.

Double, and even triple, insulating glass is also available, and should be considered in northern areas to prevent heat loss on cold winter nights. A further option is glass treated with low-emissivity or "low-e" coating, which admits light and solar heat, then traps the heat by reflecting reradiation from objects inside. Besides being energy efficient, low-e glass can reduce condensation, block much of the ultraviolet light that fades indoor fabrics, and make the inside glass warmer to the touch.

One problem with a year-round, live-in glass addition is that it may get not too little sun but too much. Provisions should be made to shade the room in summer, by well-placed deciduous trees and/or by screening devices like roll-down blinds, which are sold by most manufacturers. (Some offer units with motorized blinds that run on tracks, or narrow, adjustable louvers that are actually sandwiched between two layers of insulating glass.) Bronze-tinted reflecting glass, which cuts light and heat transmission drastically, may be a desirable option in locations where there is excessive heat or glare, though it may limit plant growth and the color quality of the light inside does not appeal to everyone.

To provide permanent shade, and more efficient insulation against winter cold, some solarium units eliminate overhead glass entirely by using a solid, sloping roof with an overhang, or reduce the amount of glass by piercing a solid roof with individual skylights. A well-designed space of this kind blocks high summer sun but allows low winter rays to penetrate and warm the room, and is often used in energy-efficient solar designs (described below).

In addition to shading, adequate ventilation is vital for both people and plants. If possible, doors and windows should be placed to capture cross-drafts from prevailing summer breezes; this natural flow can be aided by an exhaust fan high on one end wall, with pivoting intake louvers on the opposite wall. Adjustable vents along the roof line, either hand-operated or automatic, may also be desirable to release a buildup of heat at the top of the room. A slowly rotating ceiling fan will provide a gentle, constant movement of air, mixing layers of different temperatures, and in winter bringing warm air down from above.

The flooring in any sun room that gets constant use should be durable, moisture-proof and easy to keep clean, especially if plants are set on the floor where dampness can accumu-

A lean-to greenhouse becomes part of the house and therefore a garden room. A dining table placed close by allows guests to enjoy the atmosphere and plants.

Photo by Roche

A collection of begonias interspersed with other foliage plants thrive along the edges of this garden room. Shading devices may be needed in some garden rooms to cut down on sunlight.

late under their pots (and can soon ruin carpets or wood). Vinyl flooring is available in many patterns, and is both resilient and economical; flagstone or brick set in mortar gives an attractive "terrace" look. An especially handsome material is ceramic tile, which comes in a range of warm browns, yellows and reds. While glazed tile looks nice and shiny it can be slippery when damp; unglazed tiles have greater skid resistance.

To get still more out of a sun room, consider giving it some features of so-called "passive solar" design. Almost any glass addition will add warmth to a house when exposed to the sun, but it may lose that warmth and more, unless it can be closed off from the rest of the house on cold nights or cloudy winter days. The simplest way to avoid this is to leave the old exterior house wall intact, open existing windows and doors to bring heat from the sun room into the rest of the house when the sun is shining, and close them when the temperature of the sun room drops.

For greater efficiency, some owners install closable vents high on the old exterior wall to allow accumulated warm air to flow into the house, and more vents near the floor to allow cool air to flow from the house to the outer space, thus setting up a natural convection cycle. (A thermostatically controlled fan in an upper vent can speed the process; if it is reversible, it can also be used to force warm air into the sun room to keep the temperature up on cool nights.)

Much the same effect can be obtained by replacing smaller doors and windows in the old wall with tall sliding-glass doors. When these doors are slid back by day, warm air flows into the house through the upper part of the opening, and cool air flows out from the house into the sun room along the floor. When the doors are closed at night, their double glazing provides insulation from the lower temperatures of the outer space, which can be allowed to go as low as 45° or 50° F without harm to most plants (many species, indeed, prefer cooler conditions at night). As a bonus, sliding doors can also brighten dark living areas and make the sun room a more visible, and appealing, part of the house.

To store sun heat by day, and slowly release it at night to keep temperatures from going too low, a sun room should have some materials with "thermal mass." The most common is masonry, in the form of a floor of ceramic tile or brick laid on a concrete slab, or interior walls of brick, concrete block or stone.

For more specific advice on adapting such a room to your particular situation and requirements, consult architects and greenhouse manufacturers who specialize in solar design. ⊠

This cool greenhouse becomes part of the house when the french doors are open. Although the greenhouse is not lived in, the illusion exists.

THE CONSERVATORY

J. Liddon Pennock

Mr. Webster defines "conservatory" as a dwelling-attached glass house for growing plants, especially ornamental cultivated plants. He infers, and correctly so, hat this type of structure is created to be a showcase for decorative plants rather than a growing greenhouse.

A conservatory should not be equipped with benches which are necessary to bring plants from the seedling or rooted cutting stage to total fruition. Instead, it should feature display areas to give the impression of planted beds. A conservatory is designed to have the feeling of an outdoor garden transported inside.

Although it may seem like a simple feat, it is not easy to preserve the illusion of floral bounty and, at the same time, heat a decorative plant room. The obvious place for radiation units would be in front of, or directly under the windows. This area, of course, is also the ideal location for the massing of plants. Radiant heat under the floor surface is another possible solution that proves unsuitable because specimen plants placed directly on the floor are important to the appearance of the design and yet they suffer just as any plant would suffer if placed on a warm stove.

The best location for heating units is directly under the entry or exit doors where plants would obviously never be located. Oil-fueled units are the most cost-effective system for heating a conservatory. They can be housed under the floor surface and covered with a heavy grill the length of the door openings. These units come equipped with remarkably silent fans that will efficiently circulate air throughout the room, thus insuring an even temperature at both the ceiling and the floor level. The temperature can be regulated by a thermostat to control the variation in temperature, day or night. Hot water is piped to each unit and connected directly to the hot water system emanating from the same furnaces that heat the residence.

In Meadowbrook Farm's glass room conservatory, the high roof ceiling of the room is composed of one-half-inch-thick plate glass, supported by a cast metal structural framework which rests on stone walls that match the house itself. As an alternative, an A-line roof could have been used, consisting of a strong center joist and supporting rafters about 18 inches apart with glazed thermo-pane and a double walled clear plastic material called Lexan or Polygal (a General Electric product). The interior surfaces are simply cement stucco, mixed without lime due to the high moisture content of the atmosphere.

The walls give the structure the look of a glass room rather than a working greenhouse. The room also has openings in the walls equipped with sliding panels and screening. The heating units are located under these two doorways.

Indirect lighting fixtures were installed in the ceilings of each of the recessed doors and windows. The valences are simulated carved wood panels created out of white styrofoam and molded to look like antique paneling. They conceal the sources of all the interior lighting. Additional illumination through the glass roof is supplied by 150 watt flood lights affixed out-

A conservatory is a showcase for decorative plants. The ceiling is glass supported by a metal framework. Plants are grown elsewhere and brought in for display.

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doors to the upper eaves above the glass room, contributing considerable drama to the night lighting effect.

Ficus pumila, the climbing fig, was used to conceal the metal rafters. At the base of each narrow wall area there is a 12 by 14-inch excavation cut through the marble floor into the base soil. Small ficus plants were then inserted in the exterior walls of the residence. As the vine grew up the interior wall, one leader was encouraged while most laterals were removed. The vines finally reached the rafters and commenced to cover the metal framework eventually developing into hanging swags and other forms. These have now taken the place of many hanging baskets which were used to grace the originally bare looking structural ceiling.

The eight narrow trenches containing the ficus are the only permanent planting beds. All other plants are displayed in movable galvanized metal trays matching the width and length of all the glass wall areas, except the doorways. This enables the pattern of the plant placement areas to be changed depending on the season and the quantities of plant material available. The trays are filled with pebbles to the depth of several inches, so that if there is an overflow of water, the pots will rest above the water level. This is a very important drainage factor that prevents the plants from having wet feet and thus root rot. The dampness in the pots and trays provide sufficient moisture throughout the room.

Suitable furniture is of prime importance. Furniture made of wood, aluminum, iron or wicker with upholstery that can withstand the moisture of the room is suitable. Sculpture or other ornamental features adds to the decorative effect.

In summer, the conservatory is shaded by trees—pines and *Magnolia grandiflora*, planted on the west and south sides of the structure. If deciduous trees were used they would produce shade when in leaf and good light when the leaves have fallen. If tree plantings are not feasible, provide shade with the adjustable slat screens, saran netting, or a whitewash compound to coat the conservatory roof.

The maintenance of a conservatory could be compared to that involved in any flower garden, where, to maintain perfection, a back-up area of plants is grown and dug to fill in the gaps that occur during the season. Ideally, a small working greenhouse provides the replacement material.

If orchids are part of the scenery, remove them when they are not in flower. The blooms have an exceedingly long life-span which make orchids an absolute must for this type of setting. Despite their aura of glamour, orchid plants are relatively simple to grow.

Seasonal plants such as forced azaleas and chrysanthemums can be used in a conservatory. But they must be removed when not in flower. Flowering plants that bloom over a prolonged period should be incorporated wherever possible. Foliage plants are an equally important element because they provide a leafy background.

Most importantly, creating and maintaining a conservatory is an extremely rewarding horticultural and aesthetic experience. ⊠

A background of foliage plants provides constant interest and can be supplemented by flowering plants in season. Furniture should be able to stand moisture.

Solar Greenhouses

Colleen Armstrong

Photo by Northern Lights Greenhouse

All greenhouses are solar because heat from the sun is trapped in a glazed structure. This one contains large drums of water to store the heat.

Generally speaking, all greenhouses are solar greenhouses because heat from the sunlight is trapped in the glazed structure. While energy efficient solar greenhouses maximize the amount of solar gain (the primary source for heat) and minimize heat loss during the heating season, an equal emphasis is placed on climate control. These greenhouses can vary from being 100% passive solar without back-up heat, or a combination of solar and supplemental heat.

When planning a solar greenhouse, select a design that suits your needs. There are many designs for solar greenhouses. Some people build solar structures to function as a solarium or a space heater for the home. You can choose between a custom greenhouse or a kit (see table—Solar Greenhouse Kits). Custom greenhouses tend to be more expensive buildings because they are designed to blend with the existing house. One advantage to kit greenhouses is the opportunity to visit a model or an owner in your area. Ask the greenhouse owners what is satisfactory and less than satisfactory about the kit. A financial plan is equally important; solar greenhouses are more expen-

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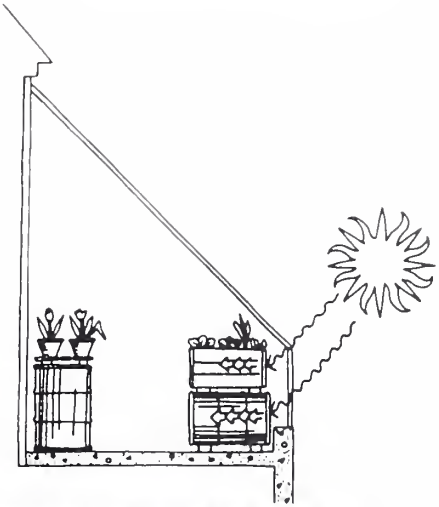


igure 1 Heat Storage and planting beds laced behind the glazing will be heated by the un. The warm root zone will boost winter lant growth.

Vhen planning a solar greenhouse, select a esign that suits your needs. Attached green- ouses are usually built on the south side of the ouse where at least six hours of sunlight reaches he area.

This lean-to solar greenhouse has been attached to the house taking advantage of the slight slope. The slope of the glazing maximizes the amount of solar radiation.

sive than the conventional types. Solar heat is not necessarily free! A low cost, do-it-yourself solar greenhouse starts at $15 per square foot; an aesthetically pleasing, quality greenhouse averages at $100 per square foot. Also, check with your local building inspector for the code laws in your town. It may save costly delays in the future.

Site considerations depend upon your choice of greenhouse—freestanding or attached. Locate freestanding greenhouses where there is plenty of light and few obstructions from trees or other buildings. There may be a warm pocket on your property where the greenhouse could be nestled away from northern winds. In cold climates, freestanding greenhouses require more thermal mass for heat storage than do attached greenhouses.

Attached solar greenhouses are usually built onto the southern side of a house where at least six hours of sunlight reaches the area. These greenhouses have the advantage of exhausting excess heat into the house, and receiving heat from the house at night. Also, the common wal between house and greenhouse protects it fron harsh, cold winds. At the same time, it restrict light from entering the northern section of th greenhouse and consequently, attached green houses are less productive than freestandin solar greenhouses.

A site survey to determine the most suitabl location for an attached solar greenhous should include the best possible southern orien tation, the least shading by trees or othe obstructions, designated lot lines and prevailin winter winds. True south is different fro "south" on the compass; solar greenhouse tex books discuss the adjustments needed for you area. A greenhouse facing true south gains th most light from the winter sun. If this directio isn't possible, locate the greenhouse 20 to 30 east or west of south. Spend some time in th

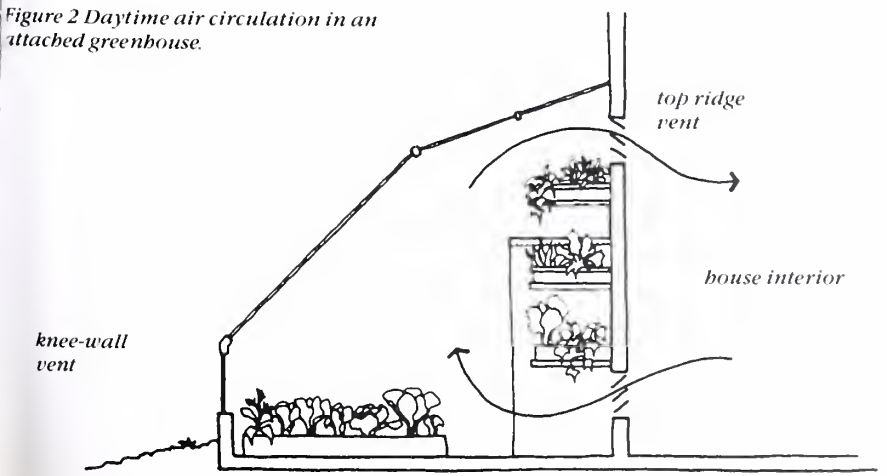
winter months plotting the sun's path over your desired location. Sketch out where the shadows are and note the angle of the sun. Within range of due south, the winter sunlight should be perpendicular to the tilted glazing. Reference books will give you the sun path chart for your latitude (see Further Reading). Equally important, you want to plot the altitude and azimuth angles of any obstructions to the sun.

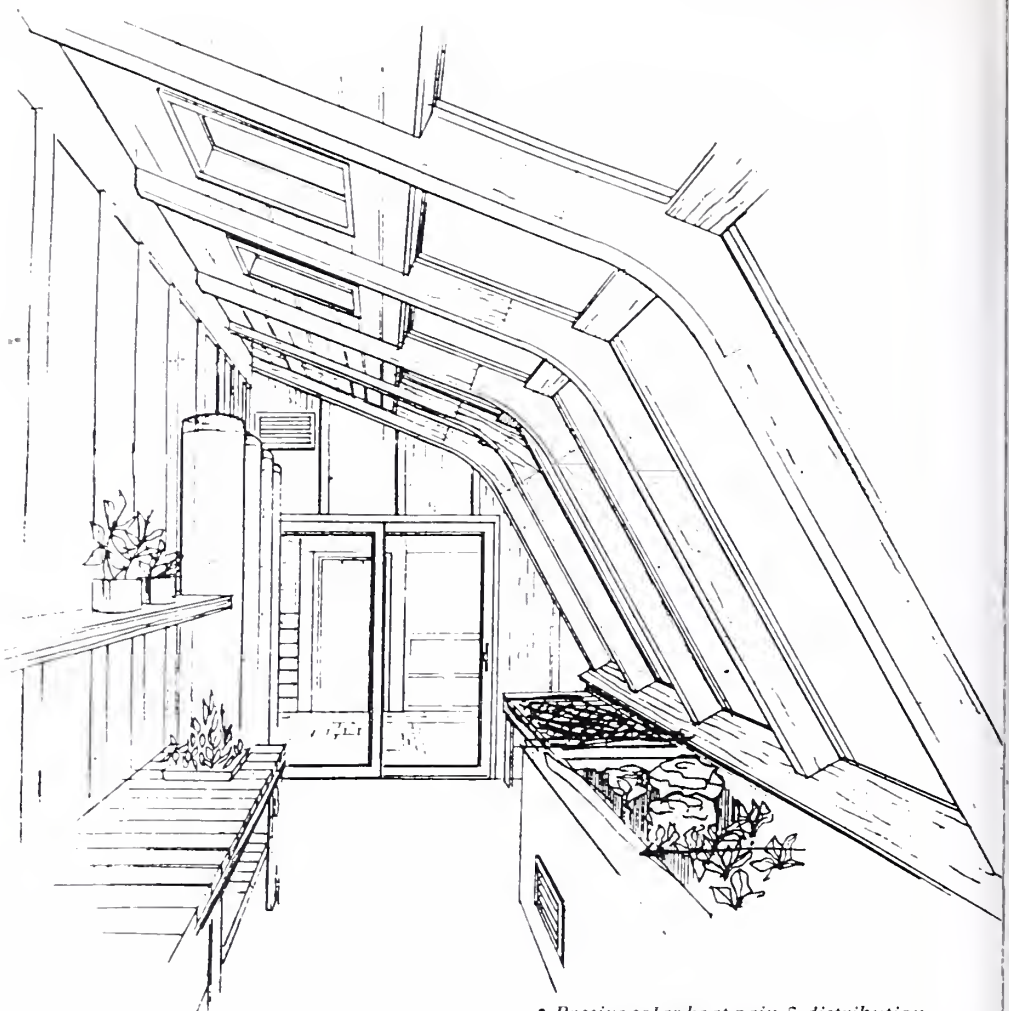
Other site considerations should include the average weather patterns for your area. Predominantly cloudy days in the winter season will dramatically reduce solar radiation when it is most needed. Note if your desired location has any peculiar microclimate qualities such as wind protection or fog. Evaluate the terrain for your greenhouse site; check for proper drainage. All of this information will aid you in deciding whether your site is suitable for a solar design.

Not all greenhouses can operate on solar energy alone. The slope of the glazing should maximize the amount of solar radiation in the winter months. To determine the slope of the southern roof glazing for your area, simply add 10 to 20° to your latitude or refer to radiation tables for the best glazing angle (see Further Reading). In order to enhance solar radiation passing into the greenhouse, consider glazing the end walls and selecting framing materials which will minimize shading. Light is important for both passive solar heating and photosynthesis. Even though a larger glazed area has more heat loss, sufficient heat storage can justify it. Your choice of glazing materials and their longevity will also affect the light transmission into the greenhouse. Reflected light can also be a source of solar energy. White paint on the interior northern wall can reflect the incoming light back onto the growing area. Materials surrounding the greenhouse, such as snow, white sand or gravel can reflect light.

During the heating season, reducing heat loss is important. Heat loss can occur by radiation, conduction or convection. In a greenhouse, most of the heat is lost from conduction through the roof, walls and air leakage out of cracks and crevices. Double glazing can effectively reduce heat loss without sacrificing light quality. The air pocket in between the two glazings limits heat loss through conduction and convection. Insulating the foundation and north wall buffers the building from cold winds and frozen soils. Caulking around overlapping pieces of glazing reduces air leakage. Movable insulation which covers the glazed roof or growing area acts as a thermal blanket. Several kit greenhouses offer accessories such as thermal curtains or shades. The Chinese use rice mats to cover their earthen bermed greenhouses. Other materials such as rigid foam insulation, reflective films and fabrics, and bubble plastics are suitable for night insulation. Thermal curtains or panels can be designed to cover the outer or inner glazing surfaces.

Figure 2 Daytime air circulation in an attached greenhouse.





- *Passive solar heat gain & distribution*
- *Passive summer ventilation*
- *Deep soil growing beds*
- *Benches & shelves for flats & plants*
- *Water tubes for heat storage*

Solar greenhouses reduce the outflow of heat by storing it in some type of thermal mass. Heat is stored most efficiently in water, and to a lesser degree in mud, masonry, rock and earth. Water can be stored in one-gallon containers stacked on top of one another, fifty-five gallon drums, tanks constructed from plastic reinforced with fiberglass or various sized containers. A general rule of thumb for cold climates: for every square foot of glazed area, one-half a cubic foot of water is recommended for heat storage. Usually water tanks are placed against the north wall where the water can absorb the heat during the day and radiate heat at night. Paint the water storage containers a dark color to increase heat absorption.

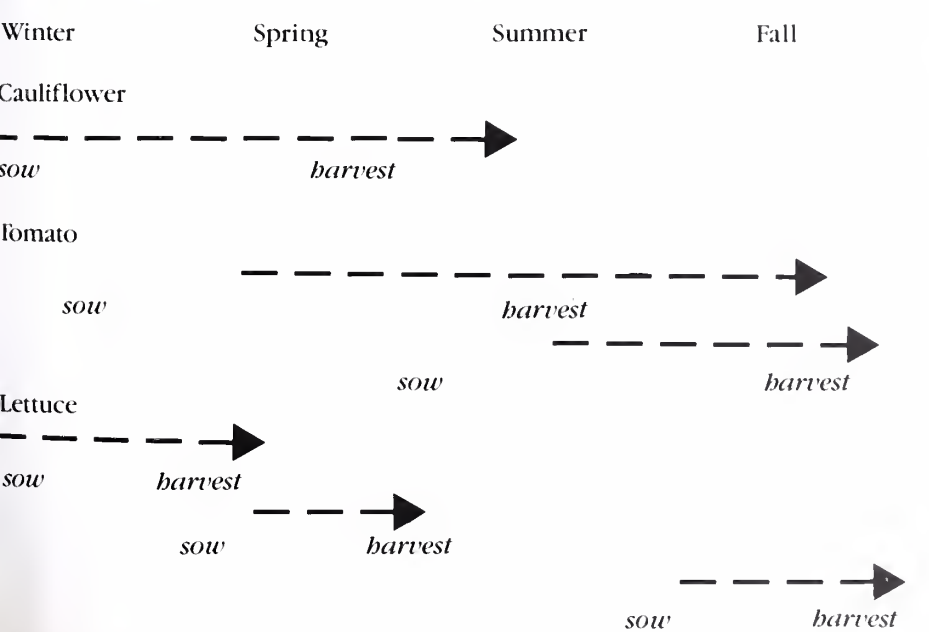
In small greenhouses, water may be an impractical thermal mass. Even though masonry has less than half the heat capacity of water, it has some advantages. A concrete wall can double as both thermal mass and structural element for both house and greenhouse and it requires less maintenance than water. Thick masonry walls (six to eight inches) tend to be more expensive than water storage systems. Deep soil growing beds absorb the heat from the sun, yet they are an inefficient thermal mass. A practical and old technique for heat storage is to build the greenhouse into a hillside and use the

irrounding soil as insulation. "Pit greenouses" are a variation on this theme; they are ailt into the ground and approximately twoiirds of the greenhouse is insulated by the round. These greenhouses are limited for light it simply designed. An expensive and sophistiated alternative is to move the hot air from the op of the greenhouse into a rock storage area elow the greenhouse floor. Heat from the armed rocks is conducted into the soil beds nd surrounds the plants. These systems require ectrical energy for fans and ductwork.

Climate control is an essential design compoent. In an effort to store the daytime heat, solar reenhouses have less regulated temperature egimes than their conventional counterparts. n most 100% passive solar greenhouses, a wide iurnal temperature fluctuation occurs roughout the heating season. Daytime temeratures can rise to 70 to 80 °F while nighttime mperatures can drop from 50 to 40 °F. Some ants will not tolerate such wide fluctuations. optimum climate conditions are necessary, then you should design for both passive solar heat and supplemental heat.

Poorly designed solar greenhouses have problems with overheating. Hot air can be ventilated from the greenhouse either passively or mechanically. Passive or natural ventilation is based on air movement by convection; warm air is exhausted out of the greenhouse while cool fresh air is drawn in. The most common natural ventilation design has windows or vents at the top of the greenhouse and low vents near the floor. The total vent area for natural ventilation should be one-sixth of the floor area with upper vents 20 to 30 percent larger than the lower vents. For windy areas, doors placed on the windward and leeward sides of the greenhouse provide adequate cross ventilation. For windless summer days, natural ventilation can be encouraged by designing for the stack effect; solar chimneys are such devices that take advantage of buoyant warm air escaping out of tall, narrow chimneylike boxes with glazing on one side. All vents should be sealed to prevent heat loss in the winter. For absent greenhouse oper-

Figure 3. Successional Planting Scheme for Vegetables in Solar Greenhouses



ators, automatic ventilation is compulsory.

Mechanical ventilation is more consistent and reliable than passive methods. Usually, a wall-mounted exhaust fan combined with side vents at the opposite side of the greenhouse is sufficient. Energy-conserving solar greenhouses have ventilation rates of four to 10 air exchanges per hour. Most commercial greenhouses recommend two to four times this rate. When selecting your fan, let this general rule of thumb be your guide: fan capacity should handle 200 cubic feet per minute for every 1,000 cubic feet of greenhouse volume. Attached greenhouses should have two sets of vents; one set for exchange into the house during fall, winter and spring seasons and another for ventilating hot air to the outside throughout the summer months.

Shading the greenhouse is another technique for controlling temperature. Most glazings can be sprayed with a shading compound which is non-toxic and easily removed with soap and water. Other options are shade cloths which are available in various grades and covering the greenhouse glazing with vegetative vines such as cucumbers, melons or runner beans. Shading may be removed earlier than conventional greenhouse shading to access passive solar heating in the fall.

Solar greenhouses can be used for season extension or year-round gardening. In northern climates, greenhouse temperature conditions mimic two seasons, spring and summer. The greenhouse glazing acts as membrane to the outdoors and the interior temperatures are sensitive to the change of seasons. Careful plant selection can make the difference between success and failure. Many growers concentrate on vegetable production in solar greenhouses because many cool-weather crops such as lettuce, cauliflower, Oriental greens, and scallions prefer springlike temperatures during the winter months. Table lists vegetable varieties best suited for solar greenhouses in northern climates. Southern growers have more flexibility with their winter selection; however, plants that respond to long day length should be avoided during short day length periods.

Many solar greenhouse growers will start their cool weather seedlings in late summer in order to have mature, ready-to-harvest vegetables before the gray days of winter begin. For a steady harvest of leafy greens, pick the outside leaves instead of cutting the entire plant. The mature plant will continue to grow and produce throughout the coldest months of the year. Parsley, coriander, dill, and chives are tasty additions to the list of winter greens. Flowering plants that prefer cool temperatures and thrive in solar greenhouses include viola, calendula, primula, alstroemeria, freesia, nasturtium, alyssum, sweet pea, snapdragons and stock. Many orchids such as cymbidium, dendrobium, odontoglossum, cypripedium and miltonia flourish in the cool, moist climate.

Solar greenhouses have an extended summer season; heat-loving vegetables and flowers can be grown for six months or longer. Early season tomatoes, European cucumbers (the long, seedless, burpless variety), peppers and eggplant can be harvested for twelve to twenty weeks. Annual flowers such as marigold, dwarf dahlia, morning glory, impatiens, begonia and salvia can be sown in early winter; soon thereafter, they'll offer splashes of color.

Developing a plan for successional planting makes for steady production as well. Figure 3 is one example of an annual planting guide for a solar greenhouse. As years go by, you will learn the individual characteristics of your greenhouse and you can modify the planting scheme. ⊠

Vegetable Varieties for Solar Greenhouses

	Cool Season	
Vegetable	Name of Variety	Light Condition
Beet	Ruby Queen	Direct
Cauliflower	Opaal	Direct
Celery	Utah 52-70 Improved	Direct
Chard, Swiss and Red	Fordhook, Rhubarb	Partial
Chinese Cabbage	Yellow Radish Bud	Direct

ıdive	Full-Heart Batavian	Direct, Partial
	Green Curled	Direct, Partial
ıle	Gr. Curled Dwarf Scotch	Direct, Partial
ttuce, ose-leaf	Green Ice	Direct
ttuce, ttercrunch	Salina, Vasco	Direct
ttuce, maine	Winter Density	Direct
ıc Choi	Pac Choi	Direct, Partial
ıdicchio		Direct

Warm Season

ucumber	Lemon	Direct
ıropean ucumber	Coronna, Vetomil, Super Sandra	
elons	Ambrosia, Charentais Improved	Direct
ppers, reen	Ace, California Wonder	Direct
ppers, Red	Sweet Round Red	
ppers, llow		
ımato	Sweet 100 (Cherry) Caruso Park's VFNT greenhouse Jumbo Floramerica Vendor	Direct

Further Reading

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Mazria, Edward. *The Passive Solar Energy Book.* Rodale Press, Emmaus, PA, 1980.

Shapiro, A.M. *The Homeowner's Complete Handbook for Add-On Solar Greenhouses & Sunspaces.* Rodale Press, Emmaus, PA, 1985.

Smith, Shane. *The Bountiful Solar Greenhouse.* John Muir Pub., Santa Fe, NM, 1982.

Thomas, S.G. et al. *Solar Greenhouses and Sunspaces: Lessons Learned.* Prepared by the National Center for Appropriate Technology, for U.S. Department of Energy, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., DOE/CE/15095-8, 1984.

Table of Solar Greenhouse Kits

Aluminum Greenhouse, Inc., 14605 Lorain Ave., Cleveland, OH 44111

Charley's Greenhouse Supply, 12815 N.E. 124th St., Kirkland, WA

English Greenhouse Products Corp., 11th and Linden Sts., Camden, NJ 08102

Four Seasons Solar Products Corp., 910 Route 110, Farmingdale, NY 11735

Harvester All-Weather Greenhouses, 257 Main St., Chatham, NJ 07928

Horizons Products, Inc., 9301 E. 47th St., Kansas City, MO 64133

Lord and Burnham Division, Burnham Co., Box 255, Irvington, NY 10533

National Greenhouse Co., P.O. Box 100, 400 E. Main St., Pana, IL 62557

Northern Light Greenhouse, Gardeners Supply Co., 128 Intervale Rd., Burlington, VT 05401

J.A. Nearing Co., Inc., 9390 Davis Ave., Laurel, MD 20707

Pacific Coast Greenhouse Manufacturing Co., 8360 Industrial Ave., Cotati, CA 94928

Solar Resources, Inc., P.O. Box 1848, Taos, NM 87571

Vegetable Factory, Inc., Sunbeam Structures Division, 71 Vanderbilt Ave., New York, NY 10169

Controlling the Environment in a Greenhouse

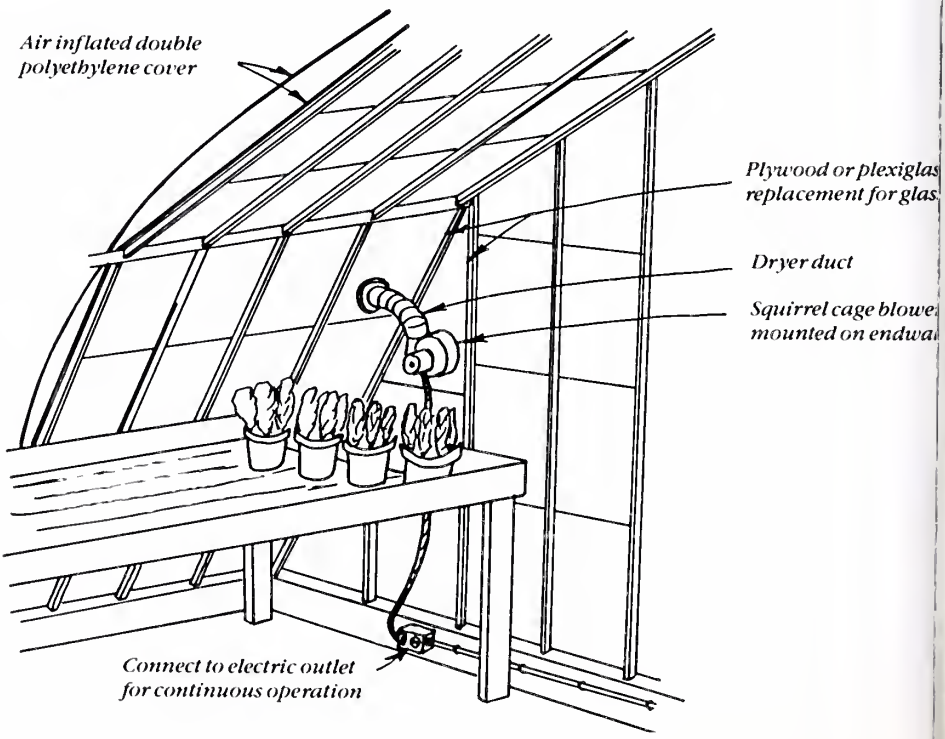
John W. Bartok, Jr.

Controlling the environment within a greenhouse in both winter and summer is important to the production of quality plants. Heat, light, humidity and air quality are all crucial factors. There is a large selection of equipment available that will fit almost any greenhouse.

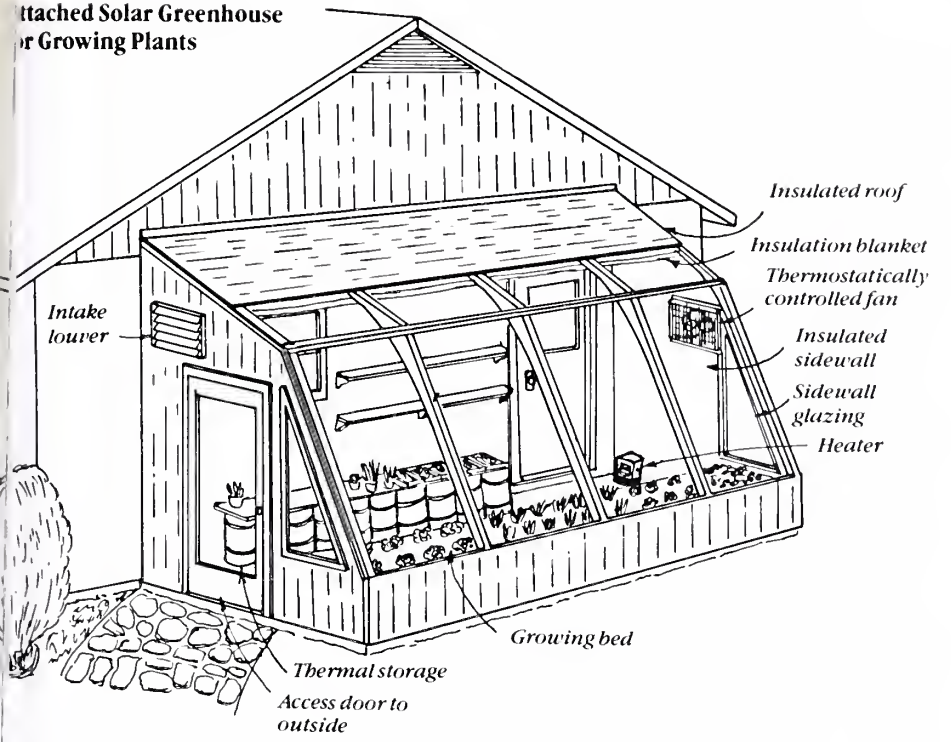
Heat

If the greenhouse is to be sufficiently warm to stimulate good plant growth during the winter, a heating system is needed. If your greenhouse is attached to your home, it may be possible to connect it with the home heating system. The first step is to determine whether

Install a Double Layer Poly Cover to Cut the Heating Bill in Half


Air inflated double polyethylene cover
Plywood or plexiglas replacement for glas
Dryer duct
Squirrel cage blowe mounted on endwa
Connect to electric outlet for continuous operation

ttached Solar Greenhouse
r Growing Plants

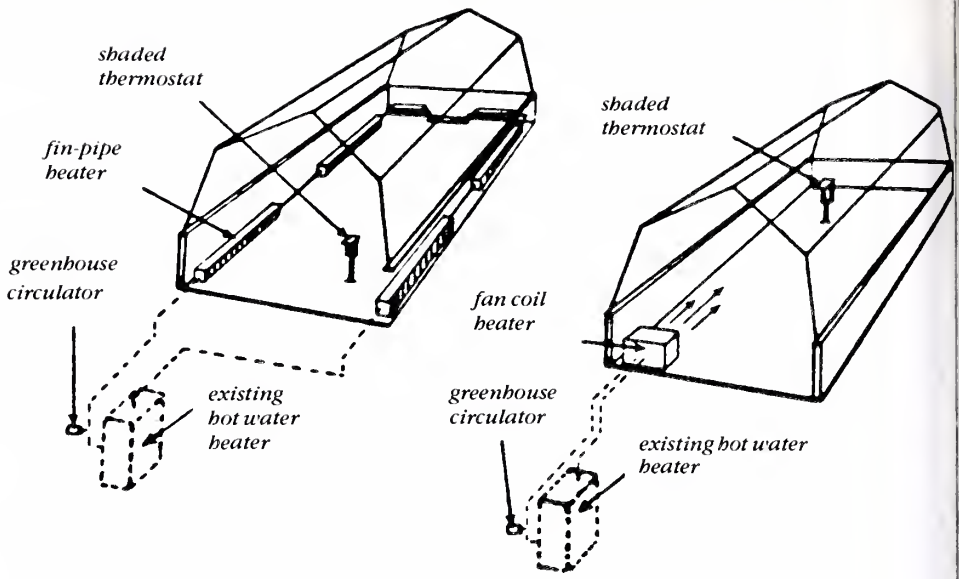


the system has the extra capacity needed to provide greenhouse heat. Check with a heating contractor. For hot water systems, a separate zone should be installed including a thermostat located in the greenhouse. For hot air systems, a separate control circuit and motorized damper are needed.

Where the central heating system is not large enough, or the greenhouse is free standing, an independent heater can be used. The electric heater is convenient, clean, efficient and easy to install; but electric energy is more expensive than other fuels. The heater should have a built-in thermostat and circulation fan. Also bear in mind that adequate electric supply and wiring is required.

Space heaters are commonly used to heat hobby greenhouses. Self-contained units that burn natural gas, LP gas or fuel oil and distribute the air with a blower are best. A separate thermostat located at plant level gives good temperature control. Some of the products of combustion are toxic to both humans and plants, therefore, fuel-burning heaters must always be vented to the outside. Non-vented heaters should never be used in a greenhouse. With all heating sytems, even distribution of heat and good temperature control are necessary to achieve uniform plant growth.

The amount of heat required depends on the temperature difference between inside and outside, the amount of greenhouse surface area and glazing, as well as the tightness of the construction. As a rule of thumb, for a free-standing greenhouse located in a northern climate with 100 sq. ft. floor area, it will take 25,000 Btu/hr heat capacity to maintain 60 °F inside on a night when it is 0 °F outside. If the greenhouse has double glazing, this can be reduced by one third. For an attached greenhouse or a greenhouse located in a southern climate, only 12,000 Btu/hr will be required.



There are several methods for reducing heat loss and thereby decreasing heating costs. One of the simplest and most effective is to line the inside of the greenhouse with plastic film over the winter months. Clear polyethylene, six mil. thick is easily installed and can be reused for several years. It is available from greenhouse suppliers and lumber yards. One disadvantage is that it will reduce the amount of light inside the greenhouse by 10 to 15 percent. In addition, if your greenhouse is equipped with ridge vents, it is difficult to find a method for opening the plastic to let heat escape on sunny winter days.

If your greenhouse has a lot of hanging baskets or obstructions overhead, it may not be practical to use the inside liner. Instead, many growers place a double-inflated poly cover over their greenhouses for the winter. The two layers are separated by the slight air pressure from a squirrel cage blower, about the size used in a hair dryer. The blower operates continuously to keep the two layers separated.

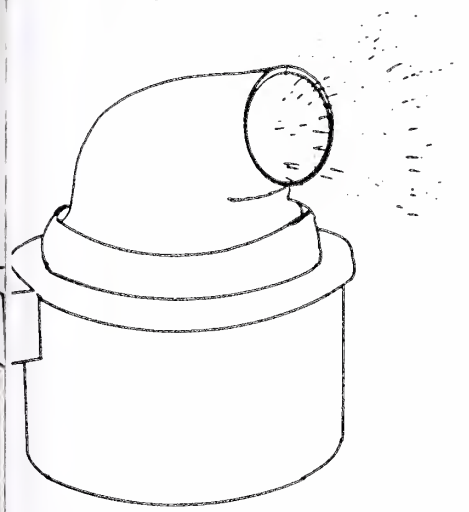
The double-inflated poly cover is easily installed. Two sheets of greenhouse-grade plastic, large enough to cover the roof and sidewalls, are needed. The plastic can be attached by using either wood furring strips or one of the aluminum extrusions available from greenhouse suppliers. The following procedures may be used:

- Wash the outside glass to ensure better light transmission.
- Cover or remove all sharp edges that could puncture the plastic. Duct tape and foam padding work well.
- Attach the plastic securing devices to the foundation wall and sidewalls. If vents are to remain operational, attach the securing devices just below the vent. Use through bolts or long screws.
- Remove a section of glass where the duct connection will be made to the inner layer of plastic.
- Select a calm day to install the plastic.
- Fasten the plastic film with the securing devices. Pull the plastic taut but don't worry about minor wrinkles, they will disappear after inflation.
- Sidewalls can also be covered using the same procedure.
- The blower should have an output of less than 100-cubic-feet per minute and a cut-off pressure of less than 0.5-inch static pressure. These are available from greenhouse or electrical supply houses.
- Mount the blower in a location convenient to where the duct will be connected to the plastic. Flexible vacuum hose or dryer duct works well for the connection.

Once the connection is made, the blower may be plugged into an electrical outlet and inflation started. A metal plate over the intake of the blower is used to adjust the pressure until it feels as taut as a medium-hard balloon.

The blower should operate continuously. It will use from five to ten cents worth of electricity a day.

This method may also be used on a polyylene-covered, wood-frame greenhouse. Several materials are available that can be ed to insulate the glass sidewalls of a greenuse. *Aircap,* the polyethylene bubble mateil found in package cushioning, may be rchased from greenhouse suppliers. It can



n electric humidifier will increase moisture vel and cool the greenhouse.

e attached by stapling or taping. However, ısulation board is a better choice for areas here transparency is not important such as oundation walls, north walls and below enches. It is available from most lumber ards; a one or two inch thickness should e used.

When building a new greenhouse, it is wise o insulate the perimeter foundation wall to a epth of about two feet below ground level. he insulation can be placed either inside or utside.

Cooling

Greenhouses need ventilation for cooling, and to reduce high humidity and replenish carbon dioxide. Exhaust fans, in combination with inlet louvers, are a convenient method of ventilation because they can be automated by wiring them to a thermostat. If a two-speed fan is combined with this system, ventilation can begin at about half-rate when the outside air is very cold.

When installing the system, the exhaust fan should be placed on the end of the greenhouse, away from prevailing summer winds. A motorized inlet louver at the opposite end is then controlled by the same thermostat that starts the fan. Purchase a fan that is sized so that the capacity is at least 12 cubic-feet per-minute (cfm) per square foot of floor area. This will be adequate to remove the summer heat. To overcome resistance of the fan louvers, the cfm should be measured at O.1 inches of water pressure.

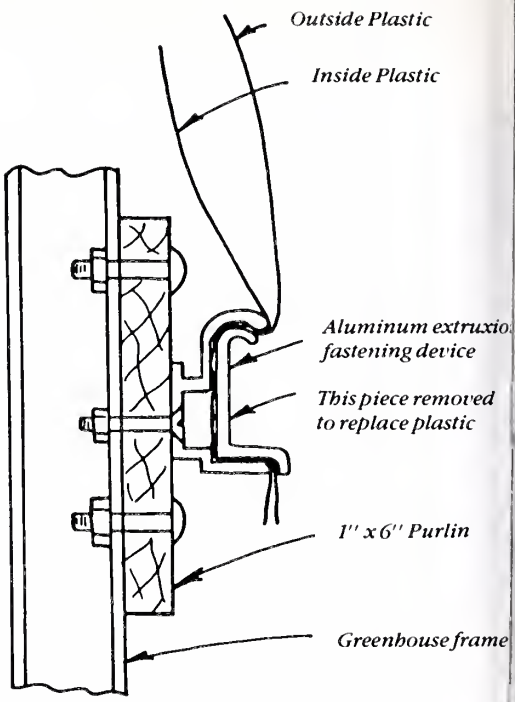
Most glass-covered greenhouses are available with vents. A continuous vent along the ridge or top of the greenhouse provides the best natural ventilation. The ridge vent operates on the principle that warm air inside the greenhouse rises to the top of the house and escapes, while cooler air enters to take its place. Side vents can help good air flow. Automatic vent controllers that open and close the ridge vent according to temperature are extremely helpful for growers who cannot constantly monitor and tend a greenhouse.

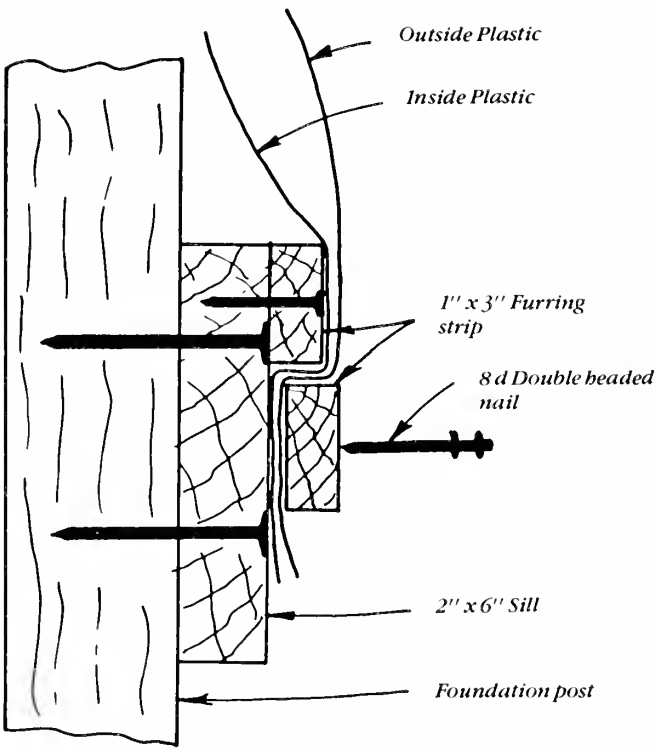
Humidity Control

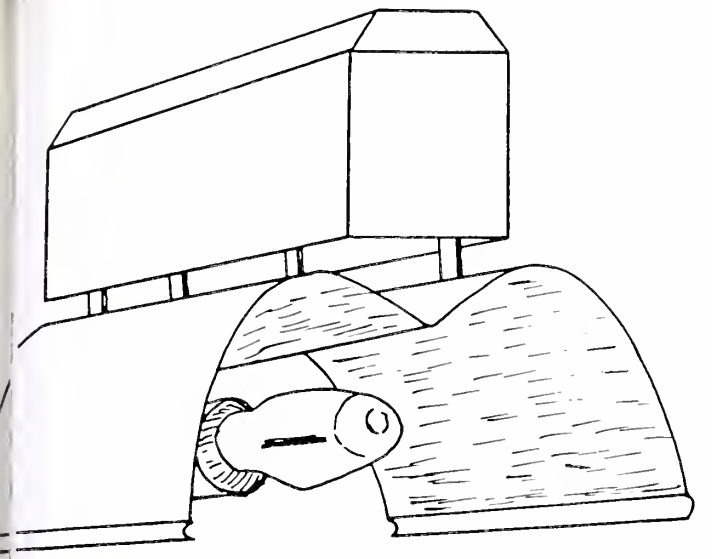
Excess humidity can cause disease problems during the spring and fall months when moisture condenses on the plants. It helps to move the air with circulating fans, but a more effective means of dehumidifying a greenhouse is to replace the moist air inside with drier outside air. This is usually accomplished by cracking the vent open or turning the fan on for a few minutes.

During the hot summer days, humidity may become too low for optimal plant growth. Wetting the walks and floor area increases

Fastening Methods for Double Inflation Greenhouse Cover







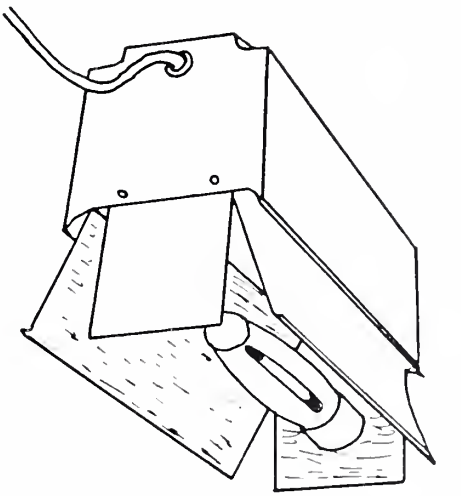
D fixture with adjustable reflectors matches tribution with area to be lighted.

imidity if it is done frequently. A small imidifier can also be used.

ghting

ght is usually the limiting factor in plant owth during the winter and on cloudy days. vo types of supplemental lighting are used. Photoperiodic lighting for day length fects the flowering of such plants as rysanthemums and poinsettias. Incandes- nt light at a very low level (less than 10 foot- ndles) also works well.

Supplemental lighting for photosynthesis lds to the sunlight that is needed for growth f tall foliage plants. A relatively high light vel (about 500 footcandles) for several hours ove the natural day length may be needed. uorescent lamps (usually cool white) or the ewer, more efficient sodium vapor or metal alide lamps are the best choice. To control em, use a 24-hour clock timer. However, efore deciding on supplemental lighting, ompare the cost to the added growth of the lants. Except for high value crops such as oses, supplemental lighting has not proved to e economically worthwhile. ⊠



Most HID fixtures can be adapted to either metal halide or high pressure sodium lamps.

HORIZONTAL AIR FLOW

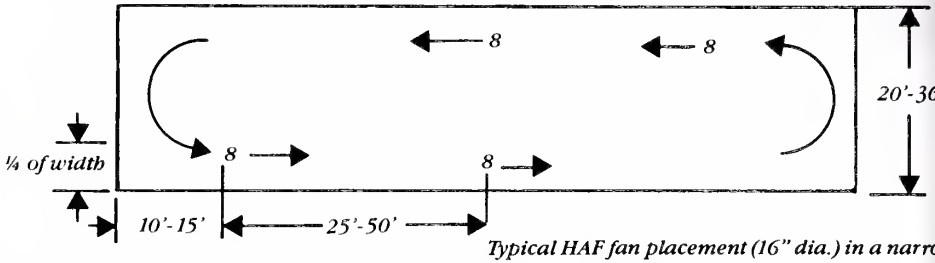
Jay S. Koths and
John W. Bartok, Jr.

Plants grow better when air is continuously circulated in a greenhouse. This cools or warms the leaf surfaces and evaporates disease-promoting moisture. Also the circulation of carbon dioxide is improved, increasing growth potential. Although several systems provide air movement, the Horizontal Air Flow (HAF) method has been found to be the most effective.

The HAF concept typically uses small circulating fans operating continuously to push the air horizontally on one side of a greenhouse and back in the other direction on the other side. This creates a circular horizontal pattern. Mixing of the air occurs from the ceiling to the floor.

Other systems use different concepts. The fan-jet system uses perforated plastic tubes suspended in the peak of the greenhouse and inflated with a one-sixth to one-half horsepower fan. The lighter heated air in the upper portion of the greenhouse is forced downward through the holes in the tube and tries to displace the heavier, cooler air near the floor. The turbulence and plant canopy slow the air movement. Losses from friction in the tube and from forcing the air through the small diameter holes in the tube increase the motor horsepower needed and the energy used.

The turbulator system uses vertical shaft fans mounted above eave height to stir the air and force it toward the eaves and back across the floor, resulting in a cold spot below the fan. These fans draw air from a limited area and many fans may be needed to make the system effective.



Typical HAF fan placement (16" dia.) in a narrow individual greenhouse.

Basic Air Movement Concept

When a fluid is enclosed in a container it may be moved in a coherent pattern with a minimum of energy. Fluid flow is energy efficient, being slowed more from turbulence caused by obstructions rather than by surface friction in the container.

This is an important concept in the movement of air (a fluid) in the greenhouse (a container). The air mass, once in motion, will continue to move until obstructions, such as plants and surface friction, slow it. For efficiency, the air mass should be as large and coherent as possible.

In a small greenhouse less than 25 feet long, this may be achieved by placing a fan in a corner. It is most efficient when directed down the house and located one-fourth the distance across the house and one-fourth the length of the house. In houses between 25 and 50 feet long, a second fan is placed in a similar

Jay. S. Koths, Storrs, CT is professor emeritus of Floriculture at the University of Connecticut.

View from inside the house into a greenhouse expands interior spaces. This greenhouse contains snapdragons, cyclamen, begonia, fuchsia and Aechmea *'Foster's Favorite'.*

An outdoor room is created by enclosing a space with walls, lath roof and a decorative double door. Tree ferns provide feathery, soft green texture while the begonia in the foreground acts as an accent.

Photos by Roche

Right *Shelving constructed along one wall of a greenhouse contains and displays a large collection of African violets. The space is used to its maximum capacity and the resulting display is decorative.*

Far Right *White wicker furniture and white latticework combine their textural elements in this garden room filled with flowering plants. Hanging baskets of nasturtiums add bright color to contrast with the white pillars and walls. Palms and other green foliage plants are the backdrop for pots of flowering plants. In the background can be glimpsed the potting shed.*

Below *A cool greenhouse provides the stage for a succession of bloom over five gloomy winter months. Amaryllis, tulips, hyacinths, narcissus and impatiens bloom in profusion. (See Barstow's article on the cool greenhouse.)*

y Elwin McDonald

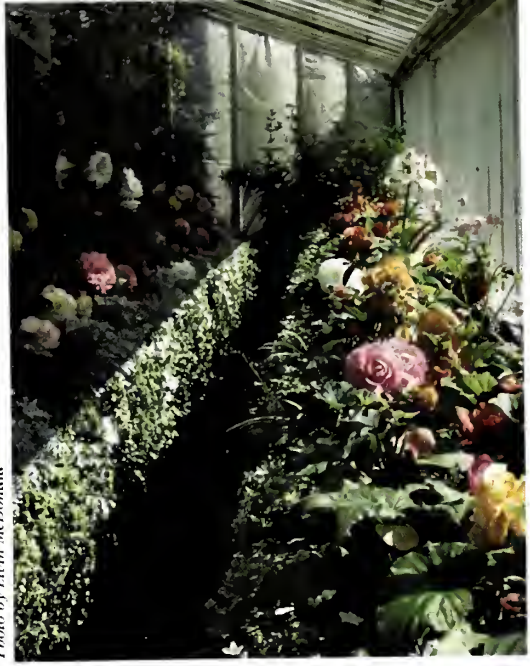


Photo by Elvin McDonald

Tuberous begonias, coleus and amaryllis are massed together and edged with dusty miller. Ivy trails over the bench sides. This greenhouse is at Butchart Gardens, Victoria, British Columbia, Canada.

A collection of spring bulbs, primroses and azaleas fill this greenhouse while the landscape outside is still clothed in winter.

Photo by Paul Frese

Plants grow better when air is continously circulated in the greenhouse. In addition to the vents such as the one shown here, even small greenhouses benefit from the use of a fan to move the air.

sition in the opposite corner. In a 100-
ot house, four fans are placed as shown in
ure 1.

The fan(s) should be placed high enough so
t the air stream is directed into as large a vol-
ne of air space as possible to minimize turbu-
ence. If the greenhouse is high enough to
ace the bottom of the fan at least seven feet
m the floor, a blade guard is not required.
e top of the fan should be at least twelve
ches from the roof.

If the fan has a rated, free-air delivery capac-
in cubic feet per minute, this should be
out three times the square feet of ground
vered by the greenhouse.

For small greenhouses, the efficiency of the
is not very important. Most small fans have
aded pole motors. A permanent split-
pacitor motor will deliver perhaps 50%
ore air per unit of electricity used, and are
commended for larger installations.

eration

ne HAF fan(s) should run continuously
henever ventilation is not required. This
y be done manually. If the vents are auto-
ted or exhaust fans are used, HAF may be
erated with the double-throw thermostat
mmonly used for controlling ventilation.
After installation, introduce some smoke to
serve the air movement in the house.

Concepts

Air is heavy. A 15' x 25' x 9' high greenhouse will contain about 300 pounds of air. Once it is moving, it will coast around and little energy is required to maintain its momentum.

Installation cost is low. Air can be moved faster with less cost than with fan-jet or turbulator systems.

Uniform temperatures exist. Moving the air at 50 to 100 feet per minute will eliminate stratification of warm air in the peak of the greenhouse. This reduces heat loss and may more than pay for the fans and their operation. It also eliminates warm and cold spots.

Plants remain drier. Air passing over the leaves reduces the humid air layer and aids the control of foliar diseases.

Carbon dioxide is used more efficiently. By "scrubbing" the leaves with air, movement of carbon dioxide into the leaf is facilitated and growth enhanced.

Plants are warmer. On cool, clear nights, radiant cooling may reduce leaf temperatures to 3 °F below outdoor air temperatures. Leaves in greenhouses will be cooler than the air if the roof is cold. Moving air transfers heat to the leaves and warms them to near air temperature.

Plants are cooler. On sunny days solar radiation heats the plants. This may cause burn on young leaves following a prolonged period of cloudy weather. Moving air cools the plant, sometimes by more than five degrees.

Pest control may be enhanced. If smoke bombs or wettable powder dusts are used, the moving air may improve the control of insects or mites.

The concept of HAF is rapidly being adopted by commercial greenhouse operators. It may improve the environment for plant growth in hobby greenhouses. In very small greenhouses, the air may be moved in different patterns, even vertically rather than horizontally. Experiment a bit. Your plants will be happier.

This greenhouse is shaded by wood lath whic is attractive and provides excellent shading f a collection of bromeliads.

GREENHOUSE SHADING

Harold E. Gray

Light is essential for plant growth but too much light can be harmful. High light can cause leaf burn and water loss and reduce flower color.

Many plants benefit from partial shading. Some orchids, many gesneriads, seedlings and foliage plants grow better when the greenhouse is shaded.

Dr. Harold E. Gray, Pana, IL is executive director of the National Greenhouse Manufacturers Association and director of VitroTech Corp of Champaign, IL. He received his PhD and was a professor at Cornell University.

ilted shading installed inside the glass provides ading when pulled down. Light is available m both ends of the greenhouse.

Aluminum shading attached to the outside of the greenhouse can be rolled up or down by sections to achieve different rates of shading.

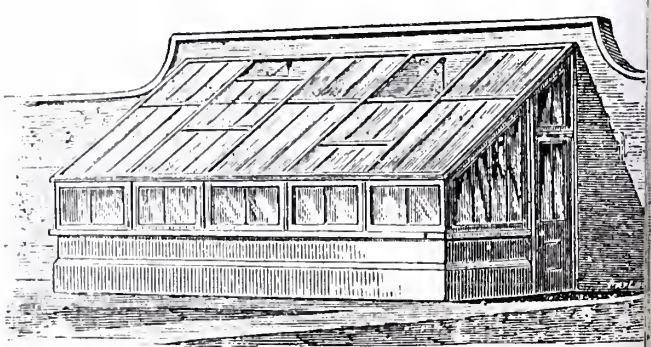


Photo by J.A. Nearing Co., Laurel, MD

Commercial growers use a shading compound — a powder or liquid that is mixed with water and sprayed or brushed on the greenhouse surface. The degree of shading is regulated by the number of coats. The compound should be washed off in the fall using detergent.

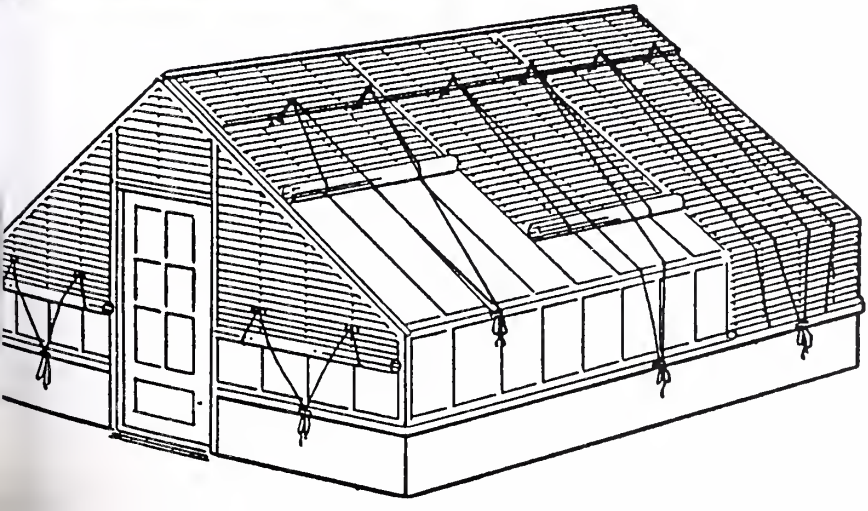
Other shading materials include evenly spaced wood slats such as snow fence placed on the greenhouse exterior. Roll-up shades are also an option and are available from greenhouse manufacturers. These shades can be constructed of wood or aluminum and can be placed either inside or outside the greenhouse.

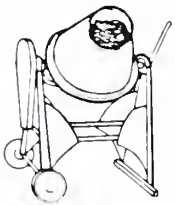
Other screening materials for exterior shading are made of plastic mesh — saran and polypropylene — available in natural, green or black. The amount of shading is predetermined by the weave of the mesh.

There are sophisticated systems which utilize tracks, rollers and rails built into the greenhouse frame. These systems can be operated by hand or motorized. Some materials also insulate to conserve heat and thereby reduce energy consumption.

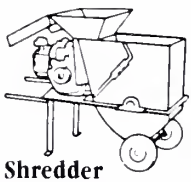
Some trial and error may be necessary as no system is ideal for every set of conditions.

Slat Shading. All of the shades can be rolled up and down the roof except those over the ventilating sash and upper part of the gable ends which are fixed with brass buttons.

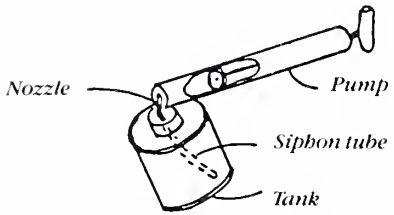




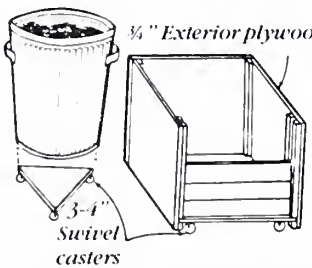
Concrete or soil mixer



Shredder



Intermittent Hand Sprayer



Storage bins for growing media

John W. Bartok, Jr.

A hobby greenhouse can be operated with a few basic tools: trowel, knife, pruning shears, pails and hose.

In addition to these standard items you might consider specialized labor-saving equipment. Some chores can be done better with a machine, leaving you more time for other activites. Greenhouse suppliers sell most of the equipment described below.

Preparation of Growing Media

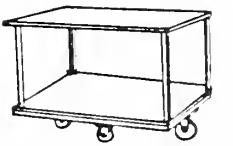
Growing media can be purchased ready-to-use or mixed in custom batches. Soil, peat, vermiculite, perlite, lime and fertilizer are the usual components of growing media. A soil shredder can be used to prepare topsoil, loosen baled peat and to mix the components. Shredders are available in capacities beginning at about four cubic yards per hour. They are powered by either an electric motor or with a gas engine. A small portable concrete mixer is an excellent soil and peatlite mixer. A one-half horsepower electric motor or two horsepower gas engine can be used to power it. A small screen is handy for removing stones and clumps from soil and is simple to make. It can be folded and stored in the headhouse or garage.

Before it is used, soil should be pasteurized to kill disease organisms, pests, and weeds. Heating is the most common and effective method used. A temperature of 140 °F for two hours or 180 °F for 30 minutes will destroy most disease organisms and weeds. Best results are obtained if the soil or mix is loose and slightly moist at the time of pasteurization. To conserve energy, only the soil needs

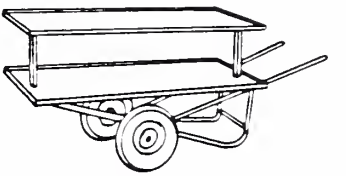
Labor Saving Equipment

o be pasteurized. It can then be mixed with peat, vermiculite, perlite or other disease-free components. An electric roaster works well for pasteurizing small amounts of soil. It will do about one flat at a time. Small commercial soil pasteurizers that process one-eighth and one-fourth cubic yard per batch are available. These also operate on electricity and use from six to 12 kilowatt hours per cubic yard.

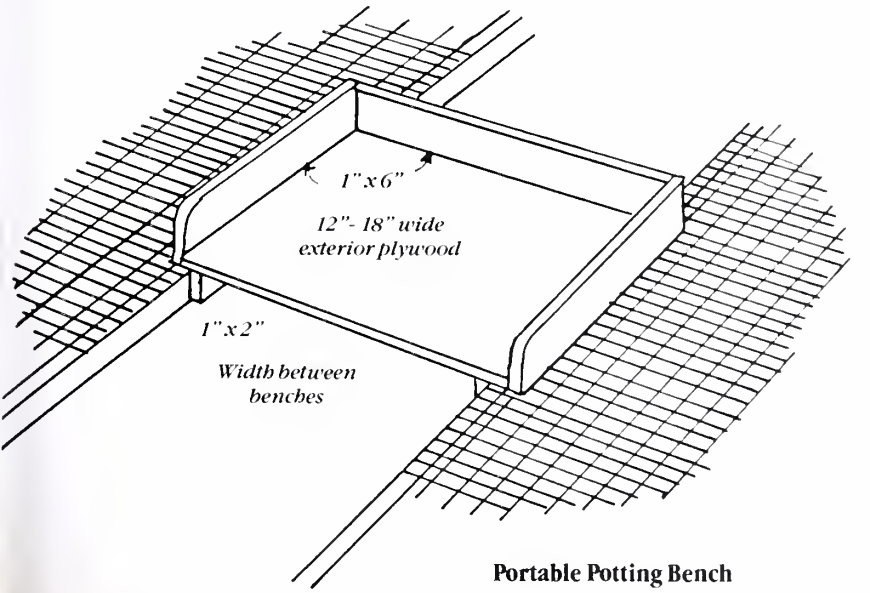
It is important that soil or mix be stored in containers or in an area where it will not be re-contaminated. The commercially prepared peat-vermiculite mixes are usually stored in their shipping containers until used.



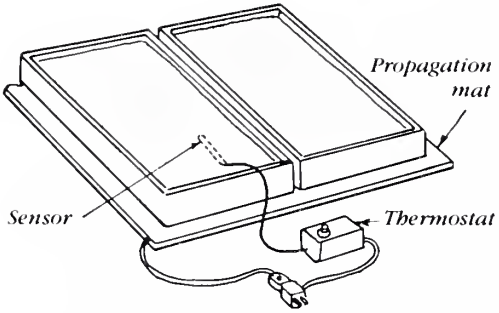
Four Wheel Cart



Double Wheel Cart



Portable Potting Bench



Propagation heat mat can provide the ideal temperature for seed germination.

Plant Treatment

Battery-powered and electric seeders aid in seeding. Seed is poured into the scoop and held over the bed or flat. The unit vibrates to feed the seed evenly.

Heating pads, and mats under the soil mix in the bench, provide additional heat for the propagation of cuttings and seedlings. They are available in several sizes. A built-in thermostat controls the temperature level.

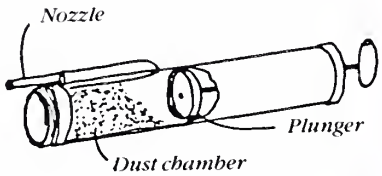
The effectiveness of an insecticide or fungicide depends to a large extent on the thorough application of the material. A hand atomizer is commonly used to apply insecticides to small areas. They are available in capacities from one-half pint to two quarts. This sprayer is inexpensive so several may be purchased, one for each type of spray material used.

The compressed air sprayer provides better atomization and spray coverage, especially to the underside of leaves. It is available in capacities from one to five gallons. Since these sprayers are not equipped with an agitator, they must be shaken frequently when wettable powders are sprayed. The plunger-type duster is commonly used to apply insecticides and fungicides in powder form.

Materials Handling

Single- and double-wheel carts are handy in the home greenhouse when materials need to be moved. Look for large wheels for easy rolling, and make sure the cart is narrow enough to go through the door.

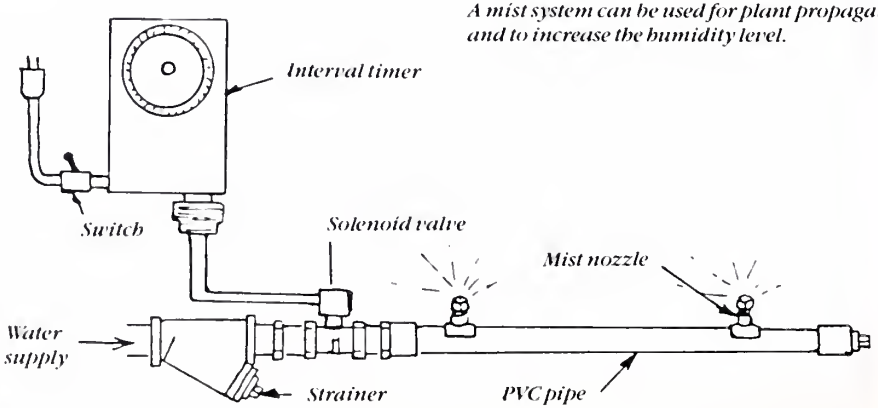
Plunger Duster



Watering and Misting

Daily hand watering with a garden hose is the most common watering system. Short hoses and several faucets are more convenient than one long hose. You should probably install more than one faucet if the greenhouse is longer than 12 feet. Water breakers attached to the hose will keep soil from being compacted

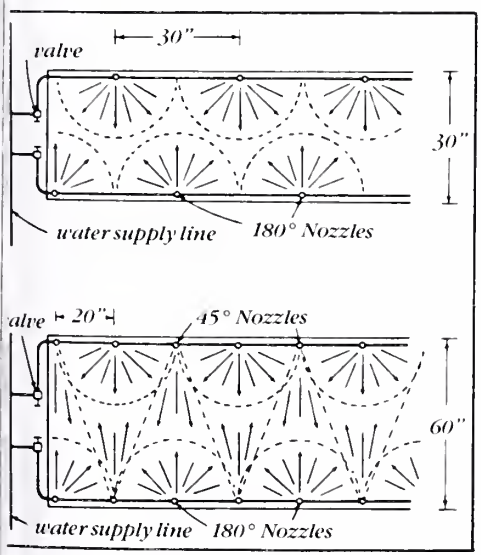
A mist system can be used for plant propagation and to increase the humidity level.



r washed out of the pot or bench. Water pot-ed plants until water begins to flow from the drainage hole. More water will only saturate he soil or reduce the amount of air in the soil; ir, as well as water and fertilizer, is necessary or good plant growth. Plants should be egregated in the greenhouse according to heir water needs as well as their growth ycles. Cacti should be separated from noisture-loving subtropical plants, for xample.

Plants should be watered in the morning so hey can dry before evening. Water droplets vill cause spotting on some plants and ncrease fungus disease. A watering can is par-icularly handy for watering potted plants in small greenhouse. The spout, with sprinkler ead removed, easily reaches beneath plant eaves to water the soil.

Automated watering systems are very con-enient for the busy gardener. Plastic nozzles



Layouts for plastic nozzle watering systems. Automated watering saves time for other projects.

are used to water plants grown in benches. A convenient system uses a polyethylene pipe clamped, or laid along both sides of the bench. Nozzles that spray in a half circle (180°) are inserted along the pipe.

The spaghetti-tube system conveniently waters potted plants. The thin tubes are inserted into a main, one half-inch diameter, polyethylene tube than runs down the center of the bench. Tubes are held in place with a lead weight, a short piece of one half-inch polyethylene tubing, or are tied to a label stake.

A time switch wired to a solenoid valve automates these systems. Some experimentation is needed to decide how long the water should run. The amount of water needed will depend on the season and the light and temperature conditions.

A line strainer should be used with any automatic watering system. The strainer filters out any sand or dirt that might clog up the small holes in the nozzles or tubes.

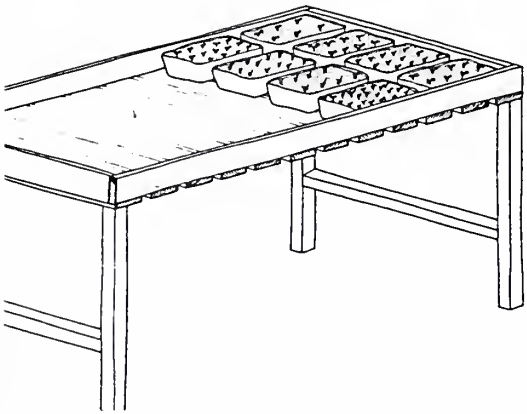
In winter, some plants may not grow well when watered with cold water. The next day's water supply can be stored in a tank or other container so it will warm to room temperature. If you use a hose or automated system, a hot water line and mixing valve can be installed.

Overhead mixing increases humidity and cools the greenhouse. High humidities are particularly important for rooting cuttings or, in some cases, germinating seed. Misting nozzles, controlled with a time switch, produce a fine spray to keep humidity high. Nozzles are normally mounted 24 to 30 inches above the bench and spaced four feet apart. Water pressure of 30 to 60 pounds per square inch is required for proper operation. Usually the nozzles are timed to operate at a ratio of one on-to-60 off, such as six seconds on and six minutes off. Air movement, temperature, and water pressure will modify this ratio somewhat. The timer controls a solenoid valve and a day-night timer or manual switch turns off the system at night. A line strainer is essential to avoid plugging the nozzles.

Capillary Mat Watering

Greenhouse Benches

Miranda Smith



Slatted Bench: This greenhouse workhorse is a great place to locate seedlings and potted ornamentals. The slats allow water to drain away.

Benches are most useful in greenhouses or areas devoted to seedling or potted ornamental production. The traditional bench design looks like a long, slatted-board table with a one-or three-inch lip. Slats allow excess water to drain. Nonetheless, protect wooden benches with a preservative (see "Tips for Long-Lasting Wooden Structures").

I prefer to make benches from wooden two by four frames covered with bench mesh, a strong metal screening available from greenhouse suppliers. It is wonderful material: strong, lightweight, easy to sterilize and non-shading. Good wire cutters or a welding torch are the only tools that will cut it. You will need U-shaped nails to attach the mesh to the frames. Turn the benches so that projecting two by fours form a lip. If you plan to use heavy pots on a wire bench, add cross-supports at three-foot intervals.

The most stable and versatile legs for benches are wooden two by four sawhorses. But almost anything else will work as well. Some people use a couple of plastic or wooden crates while others pile up cinder blocks. Height is determined by convenience; benches aren't solid enough to interfere with air circulation. I like to work with benches about three feet off the ground. At this height the root zone is quite warm, and besides, my back doesn't hurt after a long day of potting or transplanting.

Miranda Smith, North Troy, VT, has been growing and working in greenhouses since she was a child. She is the author of Greenhouse Gardening ***published by Rodale Press.***

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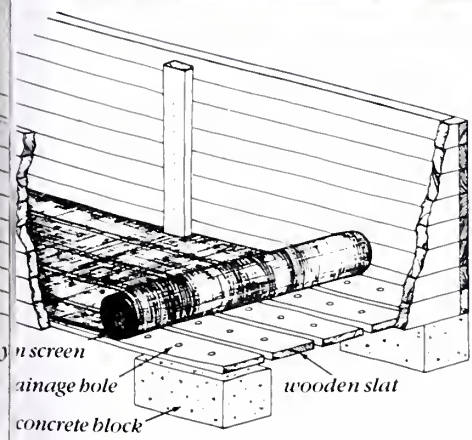
Standard wood benches hold pots of heliotrope and Easter lilies. Pots can be moved around as needed.



Deep Growing Bed: You must provide plants with good drainage and air circulation. In this bed the open-spaced slats, drainage holes and concrete blocks all ensure that water will escape and air will circulate.

Almost every greenhouse can use at least one bench. Many herbs and ornamentals grow in small pots as well as, or better than, they do in a bed. Benches also make very good starting areas for seedling flats because it is so easy to transform them into propagating chambers. The space under a bench is a handy storage area. Fill it with boxes of pots, buckets of soil mix ingredients, and jugs of liquid seaweed and fish emulsion. In the fall it is easy to clear all of the pots off the bench and use it for drying rack for onions or a curing area for a winter squash. Draped with a sheet of polyethylene, benches make good vegetable and herb drying areas. ⊠

Tips for Long-Lasting Wooden Structures

Photo by Paul Frese

This greenhouse was constructed of discarded storm windows. Wood should be treated to resist decay.

Miranda Smith

Naturally durable woods such as cedar and cypress, or lumber treated to resist decay, can prolong the life of wooden structures. Pressure-treated lumber is often used in greenhouses. Since it has been treated with arsenic compounds, the safest way to use it is as part of the structural frame. Don't use it for containers that will come in contact with the soil. Cedar and cypress, which naturally resist decay, are the best choices for growing beds. These woods can be expensive, but perhaps you can locate other growers in the area who would be willing to join forces to place a large order that would qualify for a reduced rate.

If you can't locate these woods, of if they're not available, you can use a wood preservative to treat beds and containers. The safest preservative is copper naphthenate (sold under the trade name Cuprinol). It is very effective, and while it poses no harm to plants or people, copper naphthenate does kill soil fungi and bacteria for a brief period of time after application. It also releases volatile toxic solvents as it dries. When you use copper naphthenate on lumber for beds, let the boards weather outside for a few weeks before exposing them to soil.

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A lath house made of wood provides a shady summer home for an orchid collection. Other shade loving plants would grow well under lath.

Try not to use paints or preservatives inside the greenhouse when plants are growing there. If you must do so, wait until a week when the weather is warm enough to leave the greenhouse open all night. Vent as completely as possible during the entire time that the paint or preservative is drying . . . and then add a few days for extra measure.

While I'm insistent upon treating all wooden parts of a greenhouse structure with preservatives, I use beds made of untreated wood, lined with plastic film. These beds might rot a few years before preserved wood will, but they pose no threat to soil life. I use six-mil construction-grade polyethylene stapled to the sides of the beds or to any wooden containers. I never use it to cover the bottoms because that would prevent water from draining away.

Watering a Greenhouse

Tovah Martin

There is no melody as sweet as the gentle tinkling of water as it passes from hose to pot. Without a doubt, the sound of water splashing over one thirsty plant and another is music to any grower's ear. A well-watered greenhouse is heaven on earth, whereas a poorly watered house can be hellish.

Watering is the greatest chore in the greenhouse, and also the most relentless job that a grower must perform. Day after day, week after week, month after month, a greenhouse must be watered. Even on the darkest, cloudiest day there is always a dry pot here or there. In mid-winter, the plants can wait until tomorrow. In mid-summer, their thirst can scarcely go unquenched another hour.

Although watering is definitely a chore, it is much less arduous in modern greenhouses than it was a century ago, thanks to 20th century technology. Until this century, water was collected in cisterns from roof gutters along the outside greenhouse frame. The system worked marvelously during rainy seasons. But, in times of drought, it did not *function as effectively.* When the cisterns failed, growers resorted to hauling water from nearby ponds. On a hot, dry day, as soon as they had completed one round of hauling and watering, it was time to start at the beginning and rewater the entire house.

Fortunately we now have running, piped-in water available, and every greenhouse should be equipped with water pipes. However, even with an endless supply of water at your beck and call, watering is still the ruin of many greenhouse collections. Watering may seem like a simple procedure, but every year hundreds of plants perish due to faulty watering.

No one can tell you exactly how to water a greenhouse—it is a skill that must be learned through trial and error. Anyone who waters according to a strict schedule is doomed to failure—Mother Nature simply does not go by the clock. During a rainy week your plants may only require watering twice. But on a bright, sunny week your greenhouse will probably need watering both morning and afternoon every day. Even these examples are not as simple as they seem. On a cold, rainy day the heating system might dry out plants to the point of wilting if watering is neglected. Similarly, in the summer, a cooling system might prevent the plants from drying out. Vigilance is the only truly effective method of scheduling weekly watering.

Basically, you should water when a plant is dry to the touch. Experienced growers can tell a dry plant at a glance. For those who are new at the job, feel the soil by digging a finger down about one-half inch and test it for moisture. When it is dry to the touch, give the plant a drink.

When watering, allow the hose to run with a gentle stream into the pot, directing the water with your finger, or you might try adding a wand or sprinkling attachment to your nozzle. If the water splashes out of the pot or loosens soil on the surface, it is running too strongly.

When giving a plant its drink, fill the pot to the rim with water. Every plant should have a one-fourth to one inch (depending upon the size of the pot) lip without soil, left specifically for holding water. Only fill the lip once, do not

conservatory pool provides the sight and sound water, but water must be supplied to all plants the greenhouse.

llow it to soak in and then, fill it again. And lways water in the morning so that moisture n the leaves will dry before sundown.

One of the cardinal sins in greenhouse rowing is overwatering. Everyone has done once in a while — especially with their avorite plants. It is difficult not to kill a plant vith kindness. But, it is far better to under- vater than to overwater. When you overwater, ou saturate the air pockets around the roots vith moisture, leaving the roots suffocating or oxygen. The plant can fall prey to a host of lls including root rot and other related mala- lies. In fact, a slight wilt stimulates bud forma- ion in many tropical plants. When it comes to watering, most plants thrive on neglect.

In general, you will find that plants in clay pots require more frequent watering than those in plastic containers. Hanging pots usually require twice as much water as plants set on the ground. And plants that are pot-bound and need repotting cry for water con- tinually and wilt pathetically between drinks.

Certain plants require individual care when watering. Gesneriads (members of the African Violet family) prefer warm water. You might give them their drink early in the morning if your water pipes are warmed by heating pipes. Gesneriads also object to wet foliage, so take care to water the soil and not their leaves.

In addition to water, the hose can also dis- pense fertilizer at the same time, thus accom- plishing two chores at one time. Many growers prefer to fertilize with dilute solutions (usually one teaspoon to one gallon of water) every time they water. If this method is followed, the precaution should be taken to flush residues from the plants every fifth watering with clear water. Hose attachments that fit into the spigot are available, running a slender take-up tube into a bucket filled with partially diluted fer- tilizer. Not only are you providing your plants with refreshment, you are also nourishing them.

Proper greenhouse watering is rarely mastered overnight. However, once you have learned the ropes, it comes naturally. Although it is a chore, it can be an enjoyable job. Watering is both therapeutic and fulfill- ing. A tremendous sense of accomplishment accompanies a grower as he or she watches each plant gratefully drink its share and in- stantly perk up. ⊠

Growing Vegetables in the Home Greenhouse

Karen K. Rane

Raising vegetables to maturity in a greenhouse when conditions are unfavorable for gardening outdoors provides a considerable challenge. However, the rewards are well worth the effort. With a little knowledge, patience and experience, anyone can grow a variety of garden-fresh vegetables in a small home greenhouse long after the summer is past.

Plant Selection

In addition to your personal taste preferences, deciding which vegetable crops to grow will depend on your greenhouse environment (especially the temperature and light levels) and the space available. The vegetables that are most suitable for greenhouse production include leafy vegetables, radishes, cucumbers, peppers and tomatoes.

In many cases, certain cultivars have been developed specifically for commercial greenhouse cultivation. In addition, maximum use of limited greenhouse space can be accomplished by growing cultivars developed for containers or small gardens. These tend to have a more compact growing habit than other varieties and mature more rapidly.

Temperature and Light

Vegetables require the same light and temperature conditions regardless of whether they are grown outdoors in summer or in the greenhouse in winter. During the winter, light and temperature can become limiting factors in vegetable production, especially in northern latitudes. It is often difficult to predict the time to maturity of greenhouse vegetables. When planning their planting schedules, many greenhouse gardeners fail to take into account that it may take a crop twice as long to mature when it is grown indoors.

Seedlings germinate and grow rapidly under warm conditions. Heating cables, which provide bottom heat to seedling flats, reduce the germination time significantly, especially in the winter months. However, to prevent legginess, bottom heat should be eliminated as soon as the seedlings emerge.

Optimum temperatures for growing vegetables to maturity vary according to the particular crop. Cool-season crops such as lettuce, spinach and peas grow best when night temperatures range from 50 to 60 °F, and day temperatures range from 65 to 75 °F. Warm-season crops such as tomatoes, peppers and cucumbers need night temperatures of 70 to 80 °F. While some greenhouses may have cool and warm spots allowing for the production of crops with varying temperature requirements, it is usually more practical to choose crops according to the minimum night temperature maintained in the greenhouse.

Temperatures may also be a limiting factor

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during the summer months, when cooling the greenhouse becomes a problem. Excessive heat build-up can be controlled with cooling systems and shading. But many gardeners, especially those in southern areas, find it easier to close down their greenhouses during the summer.

The duration of light is also important for vegetable growth. Some crops, such as beans and peas, are stimulated to produce flowers and fruit under conditions of increasing day length. This requirement can be fulfilled by using supplemental light during the winter, or growing the crop in early spring to take advantage of the naturally increasing day length.

Light quality and intensity are equally important. In general, vegetables grown for foliage can tolerate light of less intensity than vegetables grown for fruit production. Natural light intensity can be increased with supplemental lighting. However, it is less expensive to grow crops adapted to the prevailing light conditions of the season. Tomatoes, peppers and cucumbers will produce relatively good crops in spring and fall. Whereas, during the cloudy, short days of

Vegetables can be grown in almost any type of greenhouse. Cultivars developed specifically for commercial greenhouse cultivation perform well and those developed for containers or small gardens take up less space.

winter, greenhouse growers in northern climates will have more success with leafy vegetables. Those greenhouse gardeners who reside in southern locales generally have more flexibility with regard to vegetable production because light levels in these areas do not vary as greatly with the changing seasons.

Growing Methods

Starting vegetable plants from seed in a pathogen-free growing medium is the best way to produce plants for the greenhouse. Plants transplanted from outdoor vegetable gardens often harbor insects, weeds and disease-causing microorganisms which will continue to cause problems in the greenhouse environment and spread to other plants.

Advanced planning is necessary to have vegetable plants ready to be transplanted for greenhouse production. For example, tomato seed should be sown in late June in the Northeast for fall greenhouse production, and the spring tomato crop should be started in early January.

Ground beds

Vegetables can be planted in the soil on which the greenhouse stands if organic matter and other amendments are added to the existing soil. This method allows tall crops grown on strings or trellises to attain their maximum height. In addition, root room is also maximized.

Optimally, the soil should be pasteurized to reduce root-rotting microorganisms. Steam lines can be built into the ground bed to allow the soil to be periodically steam-pasteurized, but this is not always practical.

Bag culture

An alternative to a ground bed is the relatively recent practice of growing vegetable crops directly in bags of soilless media placed on the greenhouse floor. Plants are inserted in holes cut in the top surface of the bag, and drainage holes are cut in the bottom surface. The problem of soil pasteurization is avoided (commercial soilless mixes are free of root pests) while the use of maximum greenhouse height is maintained. A three-cubic-foot bag of peatlite mix can accommodate two large tomato plants. The bags are discarded after use to avoid root rot problems.

Containers

Containerized vegetable production is probably most adaptable to the home greenhouse, especially if the greenhouse has some sort of bench structure. There is an unlimited array of containers suitable for growing vegetables. The containers should be large enough to provide adequate room for root growth. In general, a minimum depth of nine inches and a minimum diameter of 12 inches is necessary.

Drainage holes are essential. Containers can be constructed of clay, plastic, concrete or wood. Deep wooden boxes are especially convenient for growing root crops.

Containerized vegetables thrive in a well-drained growing medium, whether it be a soilless mix or a soil-based medium. The pH should be maintained at 6.5 to 6.8. Most importantly, all components of a growing medium should be free of pathogens. If field soil is used in a home-made mix, it should be pasteurized for 30 minutes at 180 °F.

Special Greenhouse Problems

In the garden, insects pollinate flowers of vegetables grown for their fruit. But this task must be performed by the gardener when vegetables are grown in a greenhouse. Tomato, pepper, bean and pea plants can be shaken to distribute pollen. A small brush, inserted into each flower, can also be used. Cucumbers and squash must be hand-pollinated with a brush, since these vegetables produce male and female flowers separately. An exception to this rule is the European cucumber cultivars which are bred specifically for greenhouse production.

High humidity in greenhouses can encourage diseases that would not ordinarily cause problems on outdoor vegetables. Certain fungus diseases such as leaf mold on tomato plants and *Botrytis* blight on lettuce leaves can become severe in greenhouse environments.

Greenhouse vegetables are often subject to increased handling during transplanting, staking, pruning and pollination, which can spread disease-causing agents such as tobacco mosaic virus. However, simple sanitation practices, such as removing plant debris, discarding sickly plants and washing hands often while handling crops, can reduce the spread of disease. Controlling humidity levels through ventilation and adequate plant spacing will also help to control diseases in the greenhouse.

Vegetables grown in the greenhouse are subject to the same insect pests that attack greenhouse ornamentals. Careful attention to insect control is necessary for successful greenhouse vegetable gardening. Insecticides should be used with caution and according to the label directions, especially since the crop will be consumed.

Some Common Greenhouse Vegetable Crops:
Tomatoes

There are many cultivars of this crop which perform well in the greenhouse. 'Vendor', 'Caruso', 'Jumbo' and 'Dumbo' are a few of the cultivars developed specifically for greenhouse production, but many garden cultivars also produce a good greenhouse harvest. Choose cultivars that are resistant to disease.

Tomatoes can be planted as a fall or spring crop, but the harvest will be much greater in the spring. Greenhouse tomatoes may take 100 to 140 days to reach maturity from seed, and need warm temperatures (60 to 65 °F at night to 70 to 75 °F during the day) for best production.

Ground beds, bag culture and large containers are all suitable for growing tomatoes; and mulches can be used to maintain constant moisture levels. Young plants should not be over-fertilized, since this encourages soft growth, although tomato plants do require higher nutrient levels when fruit begins to develop. Tomatoes should be pruned and trained to develop a single stem, and supported with stakes or trellises. Tomato flowers are self-fertile, but the plants must be shaken to distribute the pollen.

Cucumbers

Cucumbers are a warm-season crop, and require 65 °F nights and up to 85 °F days for optimal growth. Bright light is also needed for most cultivars, making this crop more productive during the long days in spring and summer in northern areas. 'Burpee Hybrid', 'Spacemaster' and 'Victory Hybrid' are garden cultivars that also grow well in the greenhouse if hand pollinated. European cultivars which need no pollination include 'Sandra', 'Super Sandra', 'Toska 70' and 'Superator'. 'Kosura' and 'Pandex' are two European cucumber cultivars developed to tolerate lower light and temperature conditions.

Cucumbers mature in 55 to 70 days from seed, and are "heavy feeders", requiring relatively high nutrient levels as their fruit develops. For maximum production, European cucumbers must be trained to grow vertically with stakes or trellises. Other cucumber cultivars can also be grown in this manner to conserve greenhouse space.

Lettuce

Lettuce is a cool-season crop, growing best when night temperatures are 50 to 55 °F and day temperatures do not exceed 70 °F. In general, looseleaf and loosehead (buttercrunch) lettuce types are best suited to greenhouse production. Cultivars that tolerate the low-light levels typical of northern winters include 'Arctic King', 'Captain', 'Diamante' and 'Grand Rapids'.

Spring conditions in the greenhouse are ideal for most lettuce cultivars. But for late spring or early summer production, choose cultivars that are heat tolerant and slow to bolt (flower), such as 'Boston Bibb', 'Green Ice' and 'Slo-Bolt'.

Lettuce plants have shallow root systems, and can be grown successfully in relatively small containers. Lettuce should be fertilized sparingly, but it should be frequently watered to prevent its shallow root system from drying out.

Lettuce can be harvested 55 to 80 days after it is sown. In addition, the supply of this vegetable can be extended by successive plantings, or by harvesting outer leaves while leaving the plant intact. ⊠

Growing Cool-Loving Plants in a 19th Century Greenhouse

Henrietta Light

The historic greenhouses on the Lyman Estate in Waltham, Massachusetts give the indoor gardening enthusiast an interesting sense of the past. The greenhouse complex, as old as any known to be still standing in the United States, was built by Theodore Lyman, a Boston merchant, at his summer home which was built between 1793 and 1798. The estate is preserved and the greenhouses kept in use by the Society for the Preservation of New England Antiquities (SPNEA).

The dwelling house was placed in a meadow between a small river to the south and a gentle wooded slope to the north. A wooded knoll to the east completes a sense of place which made "The Vale" an appropriate name.

Between 1795 and 1800 Lyman had a 38-foot greenhouse built into the south-facing slope beyond the back of the house site. The greenhouse was heated by fuel burned in a rectangular metal fire box which fitted into the western end of a horizontal flue. This flue ran in front of a raised bed to a chimney at the eastern end. At present this house is preserved, but it is not in use.

The next greenhouse was built about 1804 for growing citrus, pineapples, bananas and forced native fruit. It was one of many such greenhouses in the Boston area, where an aristocracy of successful merchants showed energetic and often scholarly interest in growing exotic fruit and improving native varieties. Plants were grown in the south-facing half of the house, and the back wall of the plant room divided it from storage space on the northern side which acted as a buffer against the cold. The builders did not know that 180 years later such a structure would be called "solar."

Around 1820 a greenhouse was added for camellias. In the relatively few years since the

The greenhouses at the Lyman estate are as old as any known to be standing in the U.S. Some of the houses were used to grow citrus and other exotic fruit.

All photos by J. Daniel Bohl/NPEA

Henrietta P. Light is the horticulturist at "The Vale," an historic 19th century greenhouse maintained by the Society for the Preservation of New England Antiquities. She is also a garden and landscape designer and a horticultural consultant.

:amellia had arrived in the New World in 1797, he lovely blossoms had caught the imagination of some very ambitious growers, amateur and professional. We have no evidence that Theodore Lyman was involved in growing and hybridizing, but he certainly patronized the culture of those exquisite novelties, and made possible a superb setting in which to grow them.

The camellia house was set against, or replaced, a 75-foot section of garden wall to the east of the fruit house. Eventually, 45 feet of that wall was glassed in to form a rose house. A fifth greenhouse was built in 1935 for the purpose of growing cut flowers. It extended to the north behind the rose house.

Contemporary greenhouse enthusiasts are indebted to the four generations of Lymans whose continued interest in horticulture ensured the preservation and maintenance of the greenhouses. The estate, diminished from its original 400 acres to 27.5, was given to SPNEA in 1951.

Although most of the original exotic and native fruits are gone from the greenhouses, the grapes planted in 1870 are still thriving. Roses are gone from the center house which is now used for orchids and other tropical and semi-tropical plants. As for the camellias, there are thirteen thriving trees which are more than 100 years old and have reached heights between 15 and 25 feet!

The camellias are housed in a 15 by 90 foot greenhouse. It is a lean-to design built against a brick wall with top and side vents, manually operated, running the length of the house. The upper glass of this house (and throughout the greenhouse complex) is now insulated with a polyethylene bubble, two layers inflated by air pumped by an electric motor through plastic tubing. The camellia trees are set permanently in large, three-foot-square planters formed in the front by a vertical low wall of concrete two-feet high. This parallels the back wall of the greenhouse three feet behind. The trees are set four and one-half feet apart in soil between these front and back walls. Redwood partitions form side walls.

The camellia collection is truly the showpiece of the greenhouses. 'Alba plena' starts its distinctively long blooming season in late October. The

Camellias are planted in three-foot square planters against a brick wall. There are thirteen over 100 years old having achieved heights of between 15 and 25 feet.

other varieties follow, each at its own time, creating a peak of bloom in February. 'Peppermint' and 'Virgin's Blush' are still blooming in April. The blossoms are pink, white or red, two and one-half to four inches in diameter and often appear on almost every growing tip of a tree.

The Lyman Estate is open to the public (small admission charge). And visitors who come in from New England's damp or bitter cold, from grey days of early darkness or winter rain and

nud, take great delight in the winter garden reated by the trees. The blossoming camellias nspire the frequent query, "Can I grow these?"

The answer lies, as with most plant culture, in nderstanding the growing conditions of the plant's native habitat. Camellias originate in thin voodlands in coastal China and offshore slands. They enjoy abundant rainfall, high umidity, and well-drained soil. They can withstand high summer temperatures and light frost n winter as long as there are not wide fluctuaions in daily temperature. In a greenhouse, they equire good light but shade from bright sun, 65 o 70% humidity, a 20° F day-night temperature ange, ideally 60° during the day and 40° at night (the colder the temperature, the longer the blossoms last), well-drained soil with a pH of about 5.5, good ventilation and they prefer not to be overpotted. They should be set outside in summer, the pots sunk in the ground in filtered light or semishade.

If not controlled, camellias will eventually grow too large for easy handling. When their roots have filled a 12-inch pot, do not move the plant on to a larger pot, but root prune instead. This is an alarming process for the novice, but it is harmless to a plant with a good root system. Root pruning may be accomplished any time between late winter and early spring, before the air is so warm that the plant would be stressed. Cut away an inch and a half of soil from the sides of the root ball with a long, sharp knife, and cut three pie-shaped wedges from the sides of the bottom. Then put fresh soil into the old pot, positioning it to replace the wedges. Place the trimmed root ball in the pot and add fresh soil around the sides. Selectively prune the top growth of the plant in proportion to the amount taken away from the roots. Water well and keep the plant in a shady place for several days to minimize water loss. Two months after root pruning, cottonseed meal or any all-purpose container fertilizer may be used sparingly.

The cool greenhouse in which camellias thrive is one of the most manageable and rewarding of indoor growing environments. One of its primary virtues is the fact that there is less insect proliferation when temperatures are low. At the Lyman greenhouses, insecticides are only used as a last resort. Instead, a population of predacious spiders and wasps keep aphids, whiteflies and mealybugs at bay. Insecticidal soap is used throughout the greenhouse once a week. Watering is necessary less frequently at cool temperatures. Blossoms last longer. (Camellia blossoms may last a month!) And repotting is also less often required.

Many cool-loving plants share the camellias' affinity for low nighttime temperatures. The following plants are grown at "The Vale" in a greenhouse that goes to 45°F on many winter nights. ⊠

Lyman built a 38-foot greenhouse into a south-facing slope. Shown here is the fire box fitted into the western end of a horizontal flue. It ran to the chimney on the east end. This house is not presently in use.

Rhododendron indicum	Once triggered into bloom by the cool nights in the greenhouse, these lushly blooming beauties will last well in the house if kept well watered.
Begonia x *erythrophylla* *B. erythrophylla* 'Helix' *B. scharffii*	Grow these on the dry side in coldest weather, to prevent rotting.
Camellia japonica	This is the variety of the old trees at "The Vale." Buds of the showy blooms start to form in mid-summer, and open between October and May, depending on variety.
C. reticulata	This is a variety with a lankier growth habit than the above, with veined—"reticulated"—leaves. The larger blossomed plants are less vigorous and adaptable than japonicas.
C. sasanqua	This is more vigorous and fast growing than japonica, and more tolerant of cold and of bright light. Most sasanquas bloom between August and January, setting more buds than japonicas or reticulatas. The one drawback is that the delicately scented flowers shatter in a few days.
Clivia miniata	Keep very cool and dry until early March, when thorough watering will trigger bloom.
Cymbidium	These are terrestrial orchids whose blossoms appear between November and May, lasting eight or nine weeks! Look for miniatures to save space.
Jasminum nudiflorum	Bears yellow flowers, bare-leaved, in mid-winter.
Jasminum polyanthum	Until buds are set in fall or early winter, withhold artificial light after sundown or cover plant if there must be light.
Jasminum primulinum	The yellow blossoms are often mistaken for forced forsythia because of bloom time and color.
Lygodium japonicum	Japanese climbing fern. This offers an interesting texture, with its trailing, curling tracery of stems and leaves for which wires or trellis should be provided. Give plenty of water.
Muehlenbeckia complexa	Maidenhair vine. Another plant which provides delicate texture with its wiry stems and small tidy leaves.
Osmanthus fragrans	Sweet olive or tea olive. Inconspicuous cream-colored blossoms have heavy fragrance September through May. Grows slowly into a small tree.
Pelargoniums of all kinds	These are the geraniums of our window boxes and summer gardens, as well as dwarf-growing types and scented leaved ones (lime, lemon, peppermint, and many others) with small flowers. Let dry out between waterings, and be scrupulous about not watering in cloudy weather. This is a general rule of thumb in cool greenhouse culture, unless a plant is so dried out as to be wilting.
Primula spp.	Primroses. Beware that some people are allergic to the leaves of *P. obconica, malacoides* and *chinensis* particularly.
Rosmarinus officinalis	Rosemary. Lovely in texture and growth habit, this is a continuing source for fresh flavoring and provides a pleasing scent when touched.
Streptocarpus spp.	Cape primrose. Do not over water these purple, lavender, and white blooming relatives of the African violet.
Tibouchina semidecandra	Cut back in April and pinch tips relentlessly until August to attain a maximum of the large flat, rich purple blooms in late fall and early winter.
Schlumbergera truncata *S. bridgesii*	Thanksgiving cactus. Christmas cactus. Cool temperature, no artificial light after sunset, and withheld water in October should assure a good show of bloom.

Bulbs for forcing:	These tender bulbs should be planted in eight inch or deeper pots. The small bulbs belie their need for root space.
Freesia	
Anemone coronaria	
Hardy bulbs	Tulips, narcissus, crocus, bulbous iris. Cool greenhouse conditions are ideal for a long lasting show. Your dealer carries varieties specified for forcing.
Hedera spp.	Ivy
Soleirolia soleirolii (Helxine soleirolii)	Baby's tears
Cymbalaria muralis	Kenilworth ivy. All of these cool and moisture loving plants can be used in low pots on benches or floor in front of larger pots, as a kind of mock ground cover to add a graceful appearance to your winter garden.

This is a photo of the 1800 greenhouse with the horizontal flue. Only the top was glazed.

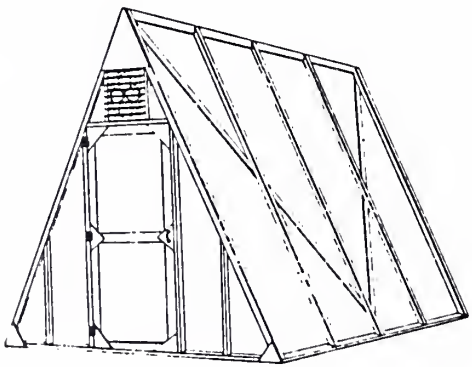
The Evolution of a Cool Greenhouse from Building to Bulbs

John Barstow

On a dull day in mid-February John Gilmore's greenhouse is a welcome sight. There is a tiny bright space jammed with the colors and scents of scores of familiar spring flowers.

Gilmore's greenhouse is a stage on which he produces a succession of glorious bloom over five gloomy months, from November through March. In any given winter week he is tending a dozen different flowering plants. Crimson and white amaryllis, drifts of butter-yellow and scarlet freesias, narcissus of many sizes and forms, and bright tulips cover practically every inch of the small bench. Tucked in among these—behind them, on crowded shelves above them, on the floor below them—are pots of pale pink, lilac, and white hyacinths; trays of lily of the valley and impatiens; cyclamen and clivias. Baskets of lantana hang from the metal rafters.

All of this midwinter color is choreographed in a seven- by 11-foot Lord & Burnham lean-to greenhouse that John Gilmore, a trial attorney, built onto his yellow clapboard house in Cambridge, Massachusetts. In 1982 when the greenhouse was constructed, Gilmore had thrift on his mind as much as blossoms. "Originally I'd planned to generate some heat for the house. But I got much more interested in gardening and much less interested in heating the house." So much so that within the year Gilmore had not only abandoned notions of economical passive-solar heat, he had purchased for the greenhouse its own furnace, a small gas-fired model



Plans such as this one and several to follow are available from: University of Connecticut. Plan No. 238, A Frame Home Greenhouse

John Barstow, Boston, MA is the managing editor of Horticulture *magazine.*

A seven- by eleven-foot lean-to Lord & Burnham greenhouse was built to contain cool growing plants. Many greenhouses can be built by the homeowner.

Reprinted courtesy of Horticulture, the Magazine of American Gardening, *20 Park Plaza, Suite 1220, Boston, MA 02116. © 1987, Horticulture Partners.*

installed in the basement not 10 feet from the big-oil burner.

Of the energy-efficient double-glazing he had specified to the manufacturer, Gilmore ruefully comments, "Yes, there's less heat loss, but there's also a reduction in light to my plants." So much for thrift. His decision to give the greenhouse its own source of heat is emblematic of Gilmore's horticultural evolution. He started with modest aims suited to his limited know-how, but he was quick to plunge in deeper as gardening became more compelling, learning as he proceeded.

The greenhouse got off to a haphazard start. Gilmore and a friend dug the four to five-foot deep foundation hole by hand in October. A contractor poured the footings and built the cinder-block foundation just before frost set in. Then Gilmore filled the hole with crushed rock, the heat sink for his passive-solar heating scheme. Once all was in readiness, the manufacturer sent a crew to erect the house itself.

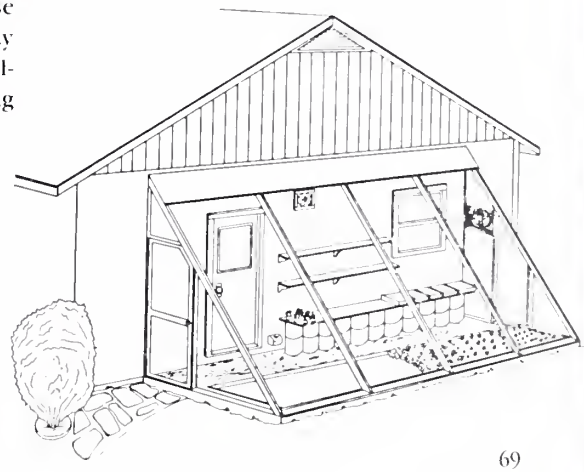
Gilmore's haste to close in the greenhouse before winter made that first season "a bit of a trial. I had no water, no heat, no floor, and no access except through windows off the living room. That spring I put in the French doors." In putting in a floor he turned his idle heat sink to advantage. Gilmore decided to leave the crushed rock exposed under the three-foot wide bench he had built against the outside wall. He finished the remainder of the floor, about half the area, in terra-cotta tiles. This arrangement affords him a clean area to stand on, while the relatively small quantity of water he uses drains through the rock. Bit by bit the greenhouse came together. "After six months of going crazy carrying water I put in a water line," says Gilmore. Eventually he installed not only running water but a mixer that combines hot and cold water in the basement and delivers tepid water to the tap in the greenhouse. Another addition, electric outlets, allowed Gilmore to work evenings: "To come home at the end of the day in winter when it's dark, turn on the greenhouse lights, and just water the plants is a joy." Thermostats, one to regulate heat from the gas furnace and a second to regulate ventilation, were installed, and Gilmore's greenhouse had arrived.

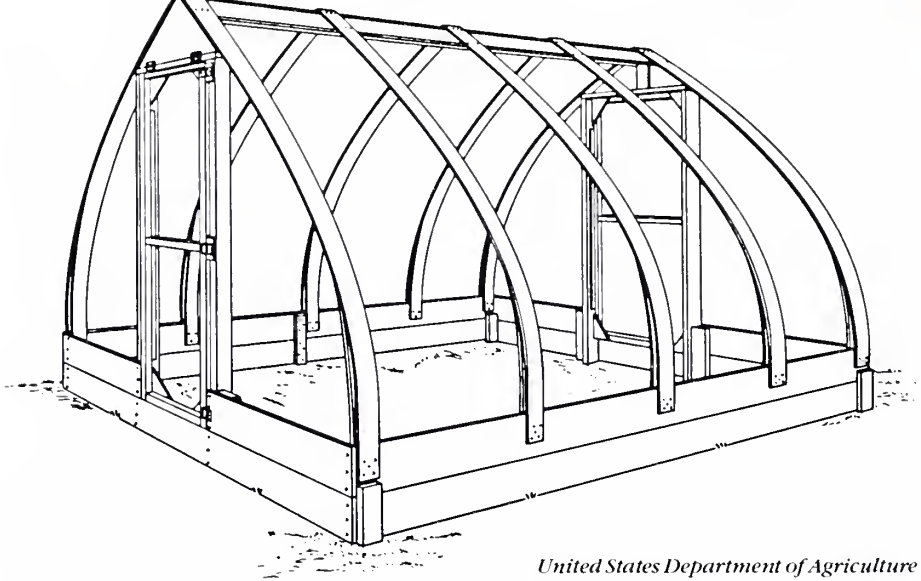
John Gilmore's greenhouse is cool. He prefers to grow hardy bulbs and other spring-flowering plants that thrive with a minimum nighttime temperature of 45 °F and a winter daytime high of 60 °F. Even though the bulbs tolerate slightly lower temperatures, Gilmore maintains a minimum nighttime temperature of 50 °F in deference to tender perennials like tropical hibiscus. He closely adheres to the 60 °F maximum temperature, however, since more heat would speed growth and substantially shorten the life of each blossom.

Gilmore's gardening seasons more nearly resemble those of New Zealand than New England. Sometime in August, when gardens (and gardeners) hereabouts are looking a little worn out, Gilmore is setting the stage for his midwinter blitz. That's when he sows his first two or three pots of nasturtium seed. For the next six

Within Gilmore's greenhouse a succession of glorious bloom brightens the winter months. In any given month he is tending at least a dozen flowering plants.

Attached greenhouse (a solar collector), University of Connecticut Plan No. 252





United States Department of Agriculture Plan No. 5946

months, every four weeks, he sows another two or three pots of nasturtiums so that he'll have some of these "filler plants," as he calls them, in bloom right through until summer.

Housekeeping is the next step in his carefully orchestrated chain of events. Before he returns his tender potted perennials to the protection of the greenhouse he scrubs down the works, including glass, walls, floor, bench, shelves, and each of his clay pots. All these being thoroughly cleansed, he sets off an insecticidal bomb in the greenhouse, closes the doors, and crosses his fingers in hopes for another relatively pest-free year.

Finally, the plants enter the scene. Tender perennials that find a place in his greenhouse include a four-year-old cattleya orchid; two tropical hibiscus that produce saucer-sized scarlet flowers all winter and spring; a jasmine "I've never persuaded to bloom;" a camellia; pelargoniums, cut back and made to bloom again; an azalea; cyclamen, "fabulous plants for a cool greenhouse that give me two months of good bloom in winter;" several agapanthus and clivias; lantanas and a venerable rosemary.

The larger potted plants occupy the floor along the wall of the house, where there is somewhat less light and temperatures are slightly cooler. The agapanthuses, which are wintering over in the greenhouse, live beneath the bench, where there is even less light. Every greenhouse has cooler spots, and Gilmore uses his widely. These established plants needn't occupy the precious growing area on the bench, and they admirably fill out corners that would otherwise be bare. The jasmine and lantana occupy hanging pots.

With the arrival of September comes Gilmore's busy season. He begins potting up the hundreds of bulbs that will bloom through the dark months ahead. In the annual replacement of bulbs, Gilmore is extravagant; he saves few—mostly amaryllis—from year to year, believing that bulbs once forced are not likely to come on strong the second year. The following 90 days are punctuated by weekends down in the basement, where a corner is given over to the implements and ingredients of the potting shed; stacks of terra-cotta pots of every size and description, seedling flats, as well as bales of peat moss, huge bags of perlite, sacks of sterile potting soil and sand.

At the far end of this jumbled corner is a small wooden door that leads through the brick foundation to a dark, cool, low-ceilinged room about six feet wide and twice as long. At its far end another door leads outside. This curious anteroom is the heart of Gilmore's little operation. It is a ready-made root cellar just far enough removed from the cellar proper to provide the cool temperatures Gilmore needs to chill his bulbs. On a typical mid-November evening the

cold room contains some 70 clay pots stuffed with bulbs.

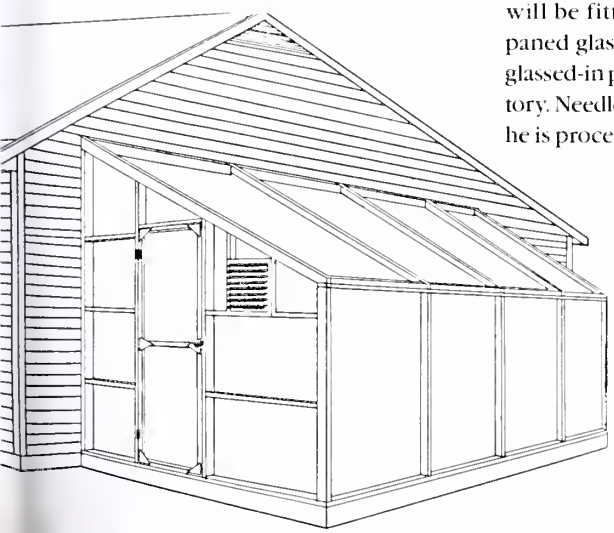
Manipulation of light and temperature is the key to tricking plants to do unnatural things, and this is where Gilmore's cold room comes in handy. In it he holds bulbs in darkness at between 45 and 33 °F (never below freezing) for anywhere from 10 to 15 weeks, the chilling period required to make hardy bulbs think they've been through winter. During this apparent dormancy they make good root growth, which equips them to produce blossoms once they are moved up into the light. Gilmore also purchases precooled bulbs which are ready to go into the greenhouse in two to four weeks, depending on how long he chooses to hold them in abeyance, and they bloom at least four weeks earlier than other bulbs.

Without this cool room Gilmore would be unable to trick his hundreds of bulbs into blooming over the course of the winter. "It's a little hard to control. I pot them over a long period but, still, when bulbs are showing several inches of growth I can't hold them any longer, I have to bring them up to the greenhouse. Bulbs newly arrived from the cold room go under the bench for a week to acclimate to the warmth and light of the greenhouse.

Once his spring-flowering bulbs begin their display in mid-December Gilmore spends more time in the greenhouse and less in the basement. He has only to water the plants regularly, fertilize occasionally (he top-dresses with an all-purpose fertilizer), keep an eye out for pests, replenish the supply of bulbs as early arrivals fade and another batch is ready to be removed from the cold, and see to it that the temperature stays within bounds. By March lengthening daylight and the higher angle of the sun begin to threaten his collection with too much heat. "In March I begin to use a fan to get the hot air out. A problem with small greenhouses is that temperatures change rapidly."

April and May mark the beginning of the end of Gilmore's greenhouse year. He sows seeds of annuals (impatiens and marigolds, mostly) that will be planted in the garden for summer bloom and gives the house its spring cleaning. To accomplish all this Gilmore figures he puts in around five hours per week from September through May. Roughly speaking, he spends two hours Monday through Friday watering and generally looking after the plants. The remaining three hours are allotted to weekend tasks like potting bulbs, sowing seed, moving plants in and out of the greenhouse, and spring and fall cleaning.

Summer is "pretty bare bones," he says. "This past year, though, I used it to better advantage. I started tuberous begonias in late spring and they bloomed all summer." So continues John Gilmore's progress. He is always trying new plants, and he is always experimenting with greenhousing. In fact, he has plans for a large porch at the southwest corner of his house. It will be fitted with floor-to-ceiling, double-paned glass. Though he prefers to call it "my glassed-in porch," it will amount to a conservatory. Needless to say he has great plans for it, but he is proceeding one step at a time. ⊠



Lean-to Greenhouse
University of Connecticut Plan No. 248

Cut Flowers for Cool Greenhouses

Many plants can be grown for cut flowers in a relatively cool greenhouse. Blooming pot plants can also be moved into the house.

James Stevenson with assistance from Deborah Matthews

Carnations, chrysanthemums, stocks and snapdragons have been popular as cut flowers for many years. All are relatively long-lasting as cut flowers and all thrive in cold greenhouses that require less energy to heat during the cold months of winter. Although only a handful of plants have attained international fame as cut flowers, there are many more lesser known flowers that are equally appropriate.

In our estate greenhouses on Long Island, we work with many cut flowers that can be grown in a cool greenhouse (maintained at 45 to 50 °F at night) with good unobstructed light, or in an unheated frame that can be covered with a layer of heavy mil clear plastic. In particular, we have had success with the following cut flowers.

Annual *Gypsophila* or baby's breath is easily grown in soil-filled flats or other shallow wooden boxes. Seed planted thinly, or thinned after germination, sprouts readily and grows quickly. Starting a new flat with seed every two or three weeks from January 1st will provide continuous cutting material for many weeks in spring.

Another highly recommended cut flower is *Saponaria vaccaria.* This is very similar to baby's breath, but pink. It is available from some of the English seed houses (such as Sutton's). Its sturdy stems will reach two-and-a-half feet, and the flowers make a most pleasing contrast with the white baby's breath in bouquets.

James Stevenson, Manhasset, NY is a gardener on a private estate on Long Island.

Photo by Paul Frese

A variety of bulbs are ideal for growing in a cool greenhouse. Purchase the best quality bulbs available.

Another annual for spring flowers that can be grown in flats is the blue lace flower, *Trachymene caerulea,* which has blossoms similar to Queen Anne's lace. All of these annuals can be grown in flats with several sowings to extend the cutting season.

Nemesia makes a charming cut flower when grown in four-inch pots. Seed should be sown in seed trays in August, transplanted into small pots when several leaves appear, and then potted up into the finishing pots. It will flower from January until March if grown in cool and sunny situations. The colors, which range from white to yellow and red are vibrant, making very pleasing small arrangements. Their stems will usually vary from six to 12 inches. A second sowing in December will produce flowers from April until June. *Nemesia* 'Blue Gem,' available from Sutton's, is a particularly noteworthy variety with small flowers that range in hue from dark blue to a blue so pale it is nearly white.

Another small flower suited to growing in four-inch pots is *Linaria.* 'Northern Lights' is a recommended variety available from most catalogs. Grown from seed started in August

in seed trays and later transplanted into small pots before being moved into four-inch containers, it will start to flower in November and continue until May. The flowers, which come in a wide range of colors, are like very tiny snapdragons and are produced on thin, delicate stems that need support either with bamboo stakes and strings, or branched twigs from shrubs.

If you can plant starters directly in the benches of your greenhouse, you can produce a good crop of calendulas for cutting. Calendulas do best in a very cool, sunny house. Seed should be sown in August (use the tallest varieties available), transplanted into small pots, and then planted into the bench. Since they will flower for three to four months, give them at least ten inches between plants. The first flowers should appear in October or November and will be largest if the side buds are pinched off each stem as the buds begin to enlarge. Whitefly can be a problem with calendulas, but constant attention will keep that pest under control.

When grown cool, given support and planted in the benches, annual candytuft will produce tall, strong stems carrying large, flat clusters of white, pink or red flowers. The large whites are the most popular florist's variety, but the white/pink/red bedding plant mixes (such as 'Fairy Mix') also produce charming cut flowers. Seed can be sown in trays in January, transplanted into small pots, then planted directly into the greenhouse bench where they should flower in May. Earlier or later sowings provide a somewhat longer blooming season, but June weather renders the greenhouse too hot for these cool-loving early cut flowers.

Godetia makes an outstanding cut flower. Seed is sown in January in trays, transplanted into small pots and then planted in a bench in March. In fact, you might try planting godetias in the calendula bench after that crop has been pulled. 'Sybil Sherwood,' available from Sutton's, is a popular variety with lovely salmon and white flowers. Though the petals of godetia appear to be delicate and easily bruised, the flowers continue to open over a long period of time. Damping-off and other soil diseases can be a problem with godetias, but starting with a sterile seed-sowing medium and careful attention to watering, ventilation and temperature will give good control.

Ammi is a charming white flower borne in large flat clusters very similar to Queen Anne's lace. If seed is sown in January, then transplanted into small pots before benching in March or April, flowers may be expected in May. *Ammi* must have plenty of support, as the plants can easily reach five feet. Equally suitable and requiring similar cultivation techniques are bachelor's buttons and sweet sultans. If treated like *Ammi*, they reach an equally tall height and will flower until hot weather arrives in late spring.

Two old-fashioned favorites for wintertime cut flower bouquets are buddleia and stevia. These two must be grown from cuttings rather than seed. Stevia *(Piqueria trinerva)* has tiny white flowers that are sweetly fragrant. *Buddleia asiatica* has long slender spikes of fragrant white flowers while *Buddleia officinalis* has shorter spikes of fragrant lavender flowers. Cuttings can be taken in March or April and grown in pots either in the greenhouse or outdoors in a cold frame during the summer. Occasional feeding and pinching will produce healthy, bushy plants. Before frost threatens, they must be brought into a sunny, cool greenhouse (45° F is sufficient) where they will flower. Although these cut flowers are otherwise easy to grow, they are prone to attacks by whitefly.

Many bulbs are ideal for growing in a cool greenhouse, particularly if you have a cold frame or root cellar available for storage, or a spot outdoors where the flats or pots of bulbs can be buried under peat moss or sand. Tulips, hyacinths, crocus and narcissus are familiar to all gardeners. However, indoor gardeners should also experiment with iris, freesias, ornamental onions, ornithogalums and lilies. As with all bulbs to be used for forcing, the grower should purchase the largest and best quality bulbs available.

Photo by Roche

Chrysanthemums are popular, long-lasting cut flowers. They thrive in cold greenhouses using less energy to heat during winter months.

The florist's iris are easy to care for as long as good ventilation is available. Iris bulbs that are not prepared for forcing should be placed in a four-inch-deep wooden flat and stored in a cold frame for several months to allow good root growth before being brought into the greenhouse. If the bulbs are "flatted" in November, they are usually ready to be brought into the greenhouse by February or March. Bulbs that have been prepared for forcing can be flatted and put into the greenhouse immediately. Be careful with your watering, allow space between the flats for extra air curculation, and do not move the flats once the buds are showing. Any damage to the roots may cause the buds to blast. Blue or white iris are usually the best varieties for forcing under glass; the yellows tend to have weak stems when grown indoors.

Freesias do not require any special handling before planting in the greenhouse. In addition, staggered planting throughout the winter will give you a long season of bloom. The most satisfactory flowers will be produced in cool greenhouses with bright light. Freesias can be planted either in pots or in the bench. In either case, staking is necessary to prevent the foliage and flowers from flopping. Not only are freesias easily grown, but their bright colors and fragrant flowers are favorites during the cold months of the year.

Ornamental onions are also attractive and easily grown. *Allium moly* has a small yellow flower perfect for arrangements. The white *A. neapolitanum* or the improved *A. cowanii* are even nicer as cut flowers. Their bulbs are simply pressed into the surface of the soil and placed in a cool greenhouse. Bulbs planted in November and grown at 50 °F nighttime temperatures will usually flower in February and March. A more carefree bulb for greenhouse forcing is hard to find.

Ornithogalum arabicum is a fascinating plant in the lily family. The white flowers, each one and a half to two inches across with a black pistil in the center, are held in clusters at the top of strong one and half-to-two and a half-foot tall stems. Ornithogalum bulbs can be grown individually in four-inch pots or planted together in flats. A root-forming period in a cold frame or a cool, protected spot should precede their placement in the greenhouse where they will flower. At 50 °F nighttime temperatures, they will usually flower in March and April, although they can be coaxed into bloom earlier if grown at 60 °F.

Lilies are spectacular flowers that can be grown during late winter and spring to make large, colorful arrangements for the house. They are relatively easy to force in a cool greenhouse, provided you begin with precooled bulbs, sterile soil and clean pots, and do not overwater. The lilies most commonly used for forcing are the Asiatic hybrids such as 'Enchantment' (red-orange), 'Connecticut King' (yellow) or 'Firebrand' (red), though many others are available. For forcing, several bulbs are planted three-to four-inches deep in a large pot. If precooled bulbs are planted in December, flowers can be cut in March. Planting a few bulbs every three to four weeks will provide cutting material over several months of spring. ⊠

A Schedule for Growing Cut Flowers in the Greenhouse

James Stevenson
with assistance from
Deborah Matthews

Photo by Roche

This attractive greenhouse could be used for growing flowers for cutting in the home. It contains a collection of begonias, petunias and marguerites.

Just as a garden should be designed on paper before applying spade to soil, a plan for producing cut flowers over a long season is equally important. To create a successful schedule for forcing cut flowers, consider the numbers of plants, seedlings or bulbs needed, and the area of bench or bed available.

A schedule is particularly important when forcing bulbs. Try to plan as much of your yearly bulb-growing needs as possible on paper before starting the project. Look through bulb catalogs for ideas of what varieties are available. Bulb suppliers will not be anxious to spend time answering your questions in September or October when they are over-extended. They are often happy to help, however, if contacted during the summer when their business is slow. They can give advice on how best to put together an order that fits your individual needs, including the scheduling of delivery dates scattered throughout the season for various planting times. Be sure to discuss shipping methods, especially if you plan mid-winter deliveries. Not all carriers can ensure the fast service necessary to prevent frozen shipments.

Starting in the spring, an unheated, plastic-covered frame house can be used to produce a great variety of cut flowers from early April until late June. After that date, you can rely on outdoor plantings of annuals and perennials to yield flowers for the house. A frame house

can be made with metal pipes or wood, constructed over fertile ground, and the flowers grown directly in the soil.

The frame house provides minimal protection. It allows you to put plastic over the bed, extending the growing season by providing some protection from frost, wind and rain. A curved-top frame house is better than a square design for this purpose because there will be less damage to the plastic from ice and snow. Posts set into the ground around the perimeter of the bed permit supports to be put up for the taller growing flowers, such as snapdragons.

Bulbs and tubers such as tulips, anemones, ranunculus and florist's iris can be planted in the ground in October or November. At this time the plastic covering is not necessary. However, it will be required for spring crops, and is more easily installed in the fall. Cutting from bulbs will begin in April for anemones and tulips and continue in May for iris and ranunculus.

Once danger of hard frost is past, seedlings that have been started indoors and hardened-off outdoors can be planted in another section of the frame house, usually as early as mid- to late-March.

Some crops which can be successfully grown this way are stocks, snapdragons, bachelor's buttons, calendula, larkspur, annual scabiosa, matricaria and annual chrysanthemums ('Eastern Star' is an old favorite and a good producer). These seeds should be sown in seed trays in January or February; they can be transplanted into small plastic pots or peat pots when several true leaves have appeared. Peat pots can be transplanted directly into the soil bed in the plastic house. However some plants, such as snapdragons, resent being transplanted into peat pots.

The quality of the cut flower plants grown under plastic, and left unheated in the early spring, is often better than the same plants grown outdoors later in the season. Each produces best under cool growing conditions, and the plastic covering will protect the flowers from all weather damage except a late, hard frost.

Watering, occasional fertilizing, staking or other support, venting when the temperatures rise, and watching for aphids are all crucial factors in producing good cut flowers. The plastic house must be checked every day for watering and venting. A grower will experience the best results if he keeps the house open as much as possible. An occasional feeding with a water-soluble fertilizer will keep your plants actively growing.

If supports are necessary for your crop, it is a good practice to erect the supports when the seedlings are set into the ground. Open wire mesh or plastic mesh is very efficient and easy to put into place. It can be purchased in three-foot or four-foot wide strips and stretched over cross-bars above the planting bed. Some of the taller plants may require a second or third layer of this support. Scratching the soil with a cultivator every few weeks, or mulching with black plastic, will keep the weeds under control—this is necessary to ensure the healthiest flower-producing plants.

In spring, as the temperatures rise, you should cut more air vents in the plastic. By June it may be necessary to remove the plastic entirely.

In mid- to late-June, when outdoor beds are beginning to produce, the plants inside the frame house can be pulled out and discarded or put on the compost pile. Soil should be improved for the next crop of flowers, which might include tall mums planted in July for cutting in October and November. Before the first frost arrives in fall, cover the frame with new plastic to protect the mums. When they have ceased to flower, or have been finished by a hard frost, prepare the bed for early spring bulbs.

With experience you can enjoy cut flowers in your greenhouse over a long period of time by carefully scheduling seed-sowing dates, planting and flowering dates, and removal dates. Chrysanthemums, snapdragons, and paperwhite narcissus will yield cut flowers in the fall. Calendulas, stevia, buddleia, snapdragons, stocks, nemesia and linaria flower during the midwinter months. Bulbs such as

Bulbs can be planted in October or November for bloom in April. Anemones, ranunculus and florists' irises can be planted at the same time.

ornamental onions, lilies, tulips, narcissus, iris, freesias and godetia, baby's breath, ammi, centaureas and candytuft will flower in early spring. For later spring flowering, all of the plants in the unheated plastic house will yield lovely flowers for bouquets.

One last word of advice—keep records of the year's activities such as seed sowing, transplanting, benching or flatting dates, first and last cutting dates, spacing and numbers of plants or bulbs used. All of this information will be invaluable for scheduling the following year's cut flowers. ⊠

The Orchid Greenhouse

Charles Marden Fitch

All photos by Charles Marden Fitch

Growing orchids over water-filled trays helps provide humidity. This collection includes plants in clay pots and wooden slat baskets.

When orchids are to occupy most of a greenhouse, the interior design must accommodate these unique tropicals. I find most orchid growers enjoy having a collection of many genera. My own collection contains genera from around the world; their mixing is successful when each orchid is placed according to its special needs.

Layers

In a typical orchid-rich region of tropical Asia or Latin America, orchids grow in three major levels. On the ground, in deep leafmold or on mossy rocks, terrestrials such as *Paphiopedilum* and *Anoectochilus* grow in low light while reed-stem *Epidendrum* and *Eria* thrive in sun.

Higher up, on tree trunks, steep rocky banks or tree crotches, live many showy genera such as *Oncidium* and *Phalaenopsis*. Finally, on fully exposed rocks, treetops and sunny limb tips dwell orchids that need maximum light and excellent air circulation. These include species of *Ascocentrum*, some *Laelia*, *Vanda*, and *Schomburgkia*.

Top to Bottom

I adapt this natural multi-level approach to habitat to fill available space top to bottom in the greenhouse. Hanging from the rafters are orchids that need maximum light. Under the highest hanging pots are those of younger orchids and genera that do well with less-intense light. On the greenhouse bench are seedlings and orchids that will bloom with the dappled light that gets through the canopy above.

These Phalaenopsis *orchids are shaded from intense California sun by overhead shade cloth placed between the roof and the plant benches.*

Charles Marden Fitch, Mamaroneck, NY, an international horticulturist and media specialist, studies orchids in their tropical habitats around the world. He is author/photographer of many books including Garden Photography *and* All About Orchids, *and guest editor of several* Plants & Gardens *handbooks.*

Stanhopea tigrina *grows best in a humid greenhouse under diffuse light. Since the flowers appear directly below the rest of the plant, stanhopeas are typically grown in slatted baskets hung from greenhouse rafters.*

Orchids need more intense light than many other popular ornamental tropicals. When you have a choice about greenhouse placement, always select an orientation with maximum sun exposure, then control intensity with shade paint, rolling shade cloth or blinds.

In my lean-to greenhouse, a wall of the house blocks the sun after mid-afternoon. As it gets less than maximum sun, I supplement the natural light with fluorescent lights. To better grow orchids against this inside wall I hang fluorescent fixtures with broad-spectrum lamps over the plants.

Under the benches I put more fluorescent fixtures so orchids can actually be grown from the floor level on up to the roof glass level. Without the supplemental fluorescent light under the inside benches, very little would grow well. Under the outside (lighter) bench one might grow terrestrial jewel orchids or similar orchids with low-light requirements. In my situation I'd rather have the flexibility of growing many genera under the benches, even though it means a higher electric bill.

Multi-Story

Some orchid growers use a two-story greenhouse if room permits. By constructing a spiral staircase and an overhead walkway, one can build a two-story greenhouse where hanging orchids fill the top story. Below, growers can create conventional raised benches at waist height. This sort of design permits many plants to fit inside a greenhouse although the actual ground footage is limited.

With this approach it is most important to have adequate air circulation. I have several small fans operating 24 hours per day, circulating the air but not blowing it directly at orchids. Aim a fan up at the roof, against a wall, or at the floor. One of my humidifiers also has a fan that goes on low speed all the time, then switches to high speed when the mist comes on.

Another way I get air circulation in a lean-to greenhouse is by using a small muffin fan to blow warm air from the house basement into the greenhouse, slightly above floor level. The air in my basement is warm because that's where the natural gas furnace, water heater, and washing machine are located. In cold weather the air helps heat the greenhouse. In warm months the basement is usually cooler than outside so the same system helps keep the greenhouse cool.

Micro-Climates

Since my favorite orchids like an intermediate to warm greenhouse (usually above 60° F at night), I use micro-climates to accommodate genera that do best with cooler nights. For example *Odontoglossum spp.* grow well for me if I keep them under an outside bench where the air goes down to about 50° on cold winter nights. Orchids that do best with warm nights, for example *Ascocenda spp.,* thrive when I hang them at the end of the greenhouse nearest the heaters. Use a maximum-minimum thermometer to find micro-climates. Here are some orchid greenhouse

details adapted from my book *All About Orchids:*

Shading

Some form of shading is often needed during summer months. Inexpensive shade paint compounds are used by many commercial growers but are rather messy for home use. I prefer to diffuse hot summer sun with frosted fiberglass panels above the greenhouse roof. Greenhouse supply firms and many orchid nurseries also sell shading fabric in various mesh sizes to give different percentages of shade. For example, a collection of mainly phalaenopsis orchids would need more shade protection than one of vandas or cymbidiums.

A modern way to shade orchids is by electronically-operated roller blinds that come down over the greenhouse roof or roll out under the glass above the plants as temperatures rise. Such electric controls work well on thermostats so orchids can be left alone with no fear that they will burn if a cloudy spring day suddenly turns sunny.

Humidity

Most orchids do best with 50 to 60 percent humidity. The orchid greenhouse should have an efficient humidifier attached to a main waterline for automatic operation. Place the humidifier so that its mist or fog has several feet of free air space before it hits the plants. Orchids too close to a humidifer may be kept too wet for their health.

Another way to increase humidity, useful on dry windy days, is to soak the floor and mist the plants. I like to use a sturdy metal watering wand called "Fogg It." The "Fogg It" comes with two nozzles. The fine mist is good for lightly wetting plants on bright mornings while the coarser nozzle is excellent for soaking the roots or wetting the floor.

In the cold weather when my "Southern Burner" natural gas stoves are working almost

Orchids grown on logs such as this Sophronitis roseum *'J&L' must be grown in a greenhouse to reach their full potential.*

Laelia rubescens *grows wild in a dry region of Costa Rica where it also receives bright sun. This orchid thrives in a bright greenhouse mounted on chunks of cork bark or tree fern.*

constantly I put a metal baking pan filled with water over each stove. As the water heats it evaporates, thus adding to the humidity.

Heating

My greenhouses are heated by natural gas "Southern Burners." One model is vented through the roof via a three-inch stovepipe. Orchid buds blast easily in polluted air so vented heaters are best for orchid greenhouses. In another greenhouse I have a non-vented, open-burner heater but the orchids still thrive since fresh air is constantly introduced to the greenhouse through floor vents and the basement-to-greenhouse fan described earlier.

Electric heat is efficient and safe for orchids but too expensive and unreliable in my area of the northeast. If I were to build a greenhouse from the ground up, I would use only vented natural gas heaters or a hot-water system with the water heated in a natural gas burner.

Air Cooling

Air cooling is required for greenhouses when outside temperatures are high. Sun beaming through the glass or plastic will heat up interiors very rapidly, a good thing in cold weather but dangerous for plants if temperatures get too high. Most orchids can survive summer days of 90 to 100 °F as long as humidity keeps pace with the heat. Relative humidity *drops* as temperatures rise so in hot sunny weather the humidifiers will be a great help in protecting plants. Having adequate vents is also good. I like automatic roof vents that open when inside temperatures reach 85 °F.

In parts of the country where summers are not too humid, orchid growers use evaporative coolers to lower greenhouse temperatures. Dry outside air is drawn over a wet fiber mat by a big fan. As the air goes through the wet fibers it is cooled and humidified. This sytem works well in areas like Southern California but isn't efficient where outside air is humid. Growers in the Northeast often use regular air conditioners to help their orchids get through summer heat waves.

These Cattleya *hybrids are grown on a staged wire-covered bench to maximize air circulation and make the most of the bench space.*

Summer Vacation

The hundreds of orchids in my greenhouses are too crowded so I give them a summer vacation outdoors. When the warm weather stabilizes, usually by June, I move many of the orchids outside where they live under tall oak trees until September. Cool-growing orchids are the first to go out and the last to be brought in. *Dendrobium nobile* hybrids and standard *Cymbidium* orchids require fall nights in the 50's if they are to bloom well. I leave these types outside until just before a frost. Warmer growers come in by early September.

Vandas prefer warm bright greenhouses. This one is Vanda *Hilo blue 'William Look'.*

Some orchid growers have sun-rooms or greenhouses where one or more walls can be opened up in warm weather. This system, along with putting plants outdoors, works where summers are humid but would not be good where humidity is below 50 percent.

Commercial and home orchid growers differ in the way they use greenhouses. The commercial growers frequently fill a greenhouse with one or two genera, the plants being neatly spaced on raised, ventilated benches.

In contrast, the home orchid grower fills a greenhouse to overflowing, usually with a well-diversified assortment of genera. This is a good idea since a multi-genera collection can have something in bloom every day of the year. The disadvantage to this year-round love of beauty is a jammed greenhouse. My final suggestion, from one who admits to having an overcrowded collection, is to build a greenhouse double the size you THINK is adequate. In a few seasons you will be pleased to have the space. ⊠

Plant Propagation

Bob Weidner

The propagation of plants is a source of great pleasure for plant lovers. Nothing quite equals the joy of producing new plants. From start to finish, propagation is the product of your own skill and efforts.

Plant propagation is a vast topic, and professionals employ many different techniques—too many to discuss in a short article. To give you some idea of the diversity of propagation techniques, Volume I of Bruce MacDonald's *Practical Plant Propagation* has no less than 634 pages devoted to the subject. Let us limit ourselves to rooting vegetative cuttings in the home or small greenhouse. Anyone who truly enjoys gardening should not hesitate to try his hand at this method of reproducing plants.

When propagating plants in the home, it is important to start with the right attitude. Do not expect 100% success with your cuttings. Rooting even a few cuttings on your first try should be considered a "success." At each attempt, you will get a little better. Concentrate on your successes and forget the failures.

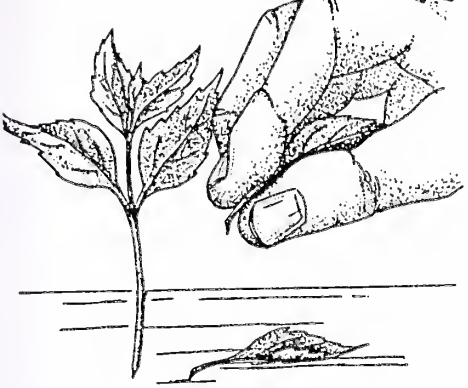
As in every aspect of gardening, preparation and planning gives the most successful results. First, one must prepare the structure in which the cuttings will be rooted. There are innumerable types in use.

The best structure is a small greenhouse equipped with three-foot-high benches. It should have an intermittent mist system over each bench, with mist lines which can be valved off in several sections. It should be shaded down to 2000 foot candles, measured midday on a bright day. An easy test is to move your hand back and forth over the surface of a bench on a bright day at noon. If the light is correct, you should almost but not quite be able to see the shadow of your hand.

Second best is a polyethylene tunnel house. There are unlimited designs of these houses and they can be put to a variety of uses. My favorite design is quickly constructed. Have a piece of ground levelled 12-feet wide and as long as you wish your house, up to 20-feet long. At the 10 foot mark, lay two 1" x 12" boards lengthwise ten inches apart and fasten them upright with stakes driven into the ground. Place 20-foot plastic pipes every five feet, bend them into hoops and attach to the 1" x 12" boards. Then cover this frame with polyethylene sheets. The plastic sheets are fastened to the 1" x 12" boards with laths and six-penny nails.

Large leaves can be clipped to about half size to allow more cuttings per unit of area and to reduce surfaces from which the cuttings can lose excessive water.

Bob Weidner of Leucadia, CA studied under T.H. Everett at the New York Botanical Garden and was past president of the Western Division of the International Plant Propagator's Society. He was the owner of Weidners' Begonia Gardens, Inc.



The leaves on lower third of cutting are removed.
Drawings by Peter Nelson

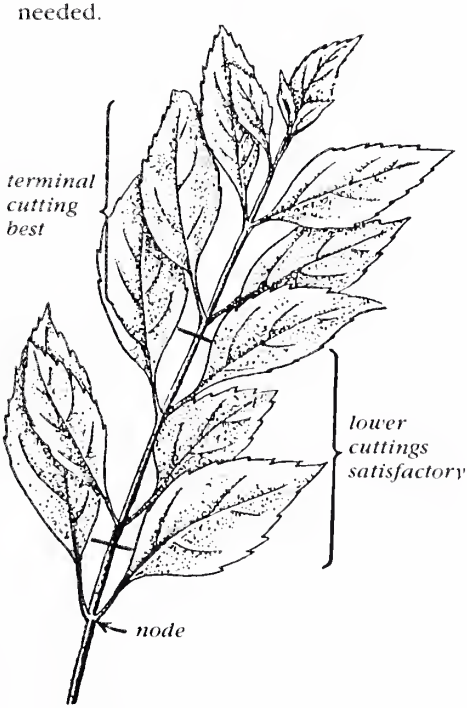
The open ends are then covered with a plastic sheet fastened at the top and rolled up on an 11-foot piece of 1" x 3" wood. This will allow a walk-in space for cleaning and also for venting when the house gets warmer than 85 ° F. The entire tunnel should be shaded to 2000 foot candles measured on a bright day at noon.

To further prepare your structure, spray the empty house and ground with a strong clorox spray, and use a pre-emergence weed spray on the ground. You will need to use two inches of one-quarter inch crushed rock on the ground to keep your flats off the soil. Finally, install two mist lines controlled by a time clock in order to give even misting.

Both of these structures are for the serious home propagator. But, the same theories can be scaled down for the small house propagator. Very small "mini-greenhouses" can be purchased. Or, a very small plastic tunnel house can be made just as easily as a large one. Simply bear in mind that the reason for any greenhouse propagating structure is to increase the humidity in the air so that the cutting will not dry out before it has made roots. Even a single pot can be made into a mini-greenhouse. Insert your cuttings, water them and cover the miniature greenhouse by placing a clear plastic bag over the top and fastening it around the rim of the pot.

Next, we must provide a rooting medium. It should be lightweight, well-drained and evenly mixed. A mixture of sand and peat is often used, and vermiculite and peat is also popular. But, both these mixes tend to hold more water than the ideal medium; and retained water tends to promote decay on the basal end of the cutting. Instead, I would recommend peat moss and perlite, in even amounts. Add Osmocote time-release fertilizer at three to four pounds per cubic yard. For convenience sake, prepare enough so you can use it on other occasions. Use a shovel or a small cement mixer to get a thorough mixing.

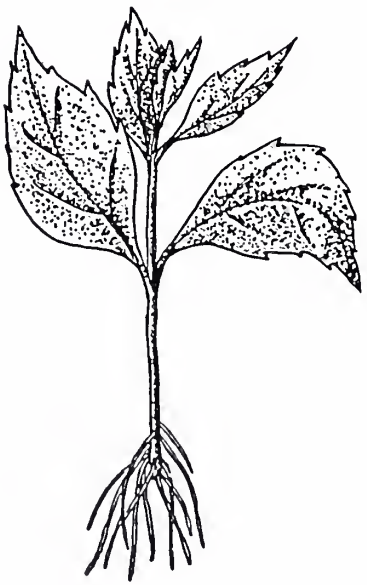
Take a metal container such as a roasting pan and fill it with soil. Insert a meat thermometer into the center of the soil mass and place it in the oven. Raise the temperature to 160 ° F and hold it there for one-half hour; then let it cool. If it is too dry, moisten it lightly. The balance of the soil should be put in a large plastic bag, tied tightly and stored until needed.



Terminal sections are best for softwood cuttings but long shoots can be cut into several sections.

Next we must think of tools, containers and materials. A very sharp knife and pruning shears are essential. Dull knives and shears tend to crush cuttings. Knives, shears and all other tools should be sterile. In the case of scarce and valuable plants, it is often wise to run knives and shears over an alcohol flame. For less crucial work, a dip in strong clorox suffices. A dibble to make holes for inserting cuttings is an aid, but a common lead pencil will do the job if only a few cuttings are being made. For larger lots, a pointed piece of dowel rod one-quarter by eight inches does a good job.

A hose with a mist nozzle or fine rose nozzle to water-in cuttings is essential. In addition, some nursery flats (the quantity depends on how many cuttings you wish to make) are the best containers. Again, they must be clean. A handy way to sterilize flats is to put a piece of polyethylene sheeting on the ground, place the flats on it, then bring up the sides and tie them to form a tank. Fill the tank with a mix of the ratio of 1:10 clorox to water, being sure to cover the flats. After ten minutes the flats will be sterile. Be careful not to reinfect them.



Rooted cutting ready for transplanting.

Next fill the flats with empty two- or two-and-one-half-inch plastic, clay or peat pots. These are then filled with sterile soil. By this method, you will have a plant with an intact ball of roots and soil, ready to continue growing on with the least amount of shock.

Having accomplished all of this preparation, you are ready to begin the actual cutting. It is very important to carefully select cutting wood. Why bother to multiply a plant with poor color, bad form or no vigor? Select a plant that has sufficiently mature growth, but not hard wood. Hard wood cuttings are another class, not to be confused with this section. We want wood that is beginning to firm up. But, in most cases, cuttings should be made before flower buds form. Many plants with flowers will root, but they usually make weaker growth as a result. Other plants, such as impatiens and begonias, only develop flowering growth and will not become bushy plants if cuttings are taken in the full blooming stage.

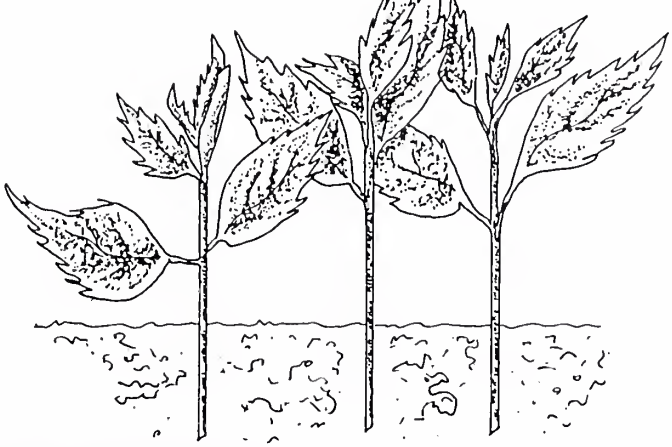
Take your cuttings just below the first or second fully opened leaf, and cut off that bottom leaf. To prevent infection, no leaf should be touching the soil when inserted. If a mass of leaves are crowded at soil level, it is an invitation for Botrytis and other serious diseases.

If you are taking a large quantity of cuttings, be sure to keep them moist by placing them in the greenhouse under mist or in the shade and covered with a wet sheet of newspaper before insertion.

You will need two dipping materials, one to speed rooting and one to help prevent disease. Rootone or Hormodin may be put in a shallow saucer. However, many gardeners do not realize that powdered rooting hormones lose their strength with time. Store them in a refrigerator!

A fungicidal dip is made up of two teaspoons of Benomyl (Benlate) to one gallon of water. Five or ten cuttings, depending on size, can be gently swished around in the dip for a few moments, immersing the entire cutting in the solution. Then remove the cuttings and shake off the surplus liquid. Next, dip the tip of the cutting in the rooting powder, tapping off the surplus powder back into the dish.

Make holes for the cuttings with your dibble



Cuttings are inserted into the medium to one fourth to one half their length.

and insert the cuttings, firming them gently with your fingers. Then use your misting nozzle to thoroughly water-in the flat and place it in the misting tunnel.

Set the timing of your intermittent mist at approximately four to five seconds every ten minutes. And watch carefully for a few days to see if the interval of mist is sufficient but not too frequent. The mist need not be on at night, unless your heating system dries the air excessively.

Check the cuttings daily for the first few weeks and remove any dead or dying leaves. If there are any signs of disease, clean the affected plants and spray them with Benlate.

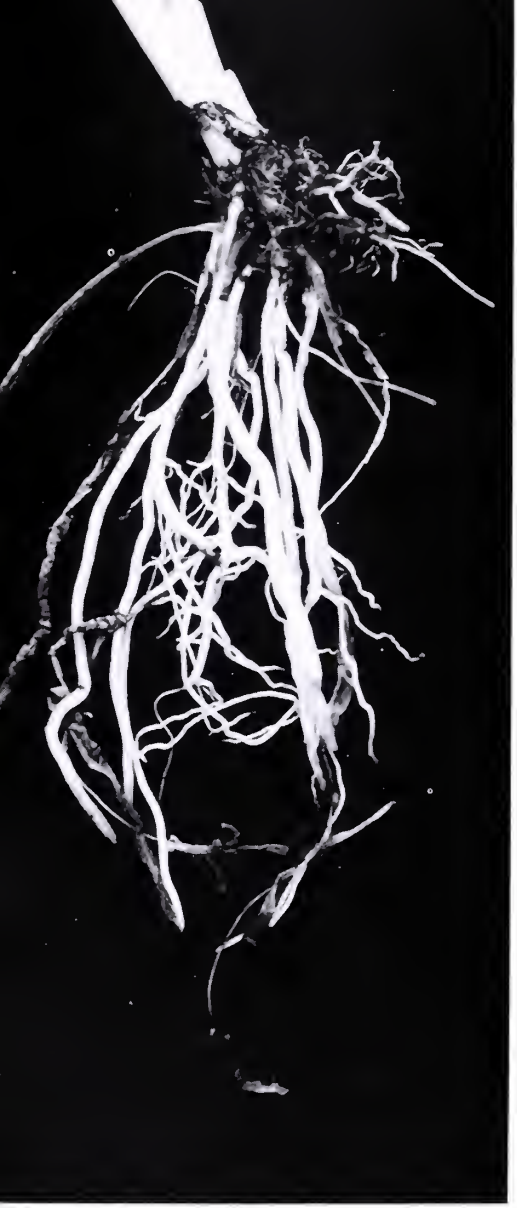
By the end of the fourth week, rooting should be achieved and the plants can be removed from the excessively moist conditions. Allow them to become accustomed to the drier air for a week or two. When the pot is well filled with roots and your small plant is growing vigorously, you are ready to pot it on into the next larger size pot.

There are other ways to propagate plants vegetatively. For example, dieffenbachias and dracaenas can be propagated by cutting their long, bare stems into segments. The stems are cut into two and one-half-inch long pieces, and each piece must have an "eye" which shows as a little bump on the stem and ensures that the piece will sprout new growth. Place the pieces horizontally in a flat in the same basic peat perlite soil mix, taking care always to position the eye facing straight up. Keep the soil continually moist, and pot up the segment as soon as the eye begins to grow.

Ficus plants present another problem because the milky sap tends to harden and it prevents the plant from taking up water. The best method of propagation is to air-layer this plant. In order to make a successful air-layer, it is essential to use a very sharp knife. You will also need a small stake (a quarter-inch by eight-inch dowel works admirably), some durable string and two handfuls of very wet sphagnum moss.

At a point at least eight inches from the top of the plant, cut or break off a leaf. Holding the eight-inch dowel as support against the stem, cut an upward slant behind the incision, but take care not to cut more than half way through, always holding the dowel rod as support. Keep the cut slightly ajar and place a little sphagnum in the opening to keep the wound open in order to prevent healing. Tie the dowel rod against the stem above and below the cut. Then place two handfuls of wet sphagnum as a ball around the wound. Finally, wrap the ball of sphagnum in one thickness of plastic. You will be able to see the roots through the plastic as they grow. When the layer is well-rooted, cut it off below the wound, pot it up and place it in a plastic tent for about a month until it is well established.

When you have mastered any or all of these three methods of propagation you can be justifiably pleased with yourself. Give yourself a big A + . . . brag a bit to your friends and be prepared for the next batch of cuttings to fail completely!



All photos by Robert L. Wick

Phytophthora *root rot of* Spathiphyllum. *The healthy roots are white and the diseased ones are brown.*

Disease Problems in Home Greenhouses

Robert L. Wick

The Causes of Plant Disease

The causes of plant diseases are diverse and include pathogenic microorganisms as well as non-living factors such as air pollution, nutritional imbalances and other environmental stresses. For the purpose of this article, only diseases caused by fungi, bacteria, viruses and nematodes that are common to greenhouses will be covered. It should be noted that most microorganisms are not capable of causing plant diseases but rather perform important functions including contributing to soil formation, releasing of nutrients from organic matter and suppressing plant pathogenic microorganisms.

Fungi are filamentous in structure and grow over or through the substrate that provides them with nutrition. Those that have evolved into plant pathogens attack living plants, causing loss of food or aesthetic value. Fungi are extremely diverse in their ecology, growth habits, form and pathogenicity. Symptoms of disease also vary and include root rot, canker, leaf spot, abnormal growth and wilt.

Fungi that survive and reproduce in the soil are termed soil-borne. They are the principal cause of root and crown (lower stem) rot. Soil-

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borne fungi generally do not produce air-borne spores but are easily transported from contaminated soil to pathogen-free soil by tools, hose ends, water splash and hands. Fungi that cause disease of stems, foliage and flowers, usually produce spores that are easily disseminated by air currents or insects.

Bacteria are very small microorganisms that occasionally cause important plant diseases in greenhouses. To put their size into perspective, approximately 600 bacteria lined up end-to-end would span one-sixteenth of an inch. With few exceptions, they cause disease by colonizing the internal tissues of plants, thereby interrupting normal growth and function. Like fungi they cause soft rots, cankers, leaf spots, abnormal growth and wilt. Plant pathogenic bacteria are also diverse in their ecological and pathological attributes. Spread of bacteria is usually by splashing irrigation water, contaminated tools and hands and by propagating from diseased plants.

Viruses are ultramicroscopic infectious particles. They can reproduce only in the presence of living host cells. Infected plants often do not show symptoms and may inadvertently introduce viruses into the greenhouse. The most familiar symptoms, mosaics, ringspots, line patterns and yellowing of the veins occur on the foliage. Tobacco mosaic virus (TMV) and tomato spotted wilt virus (TSWV) are common on greenhouse plants and can infect many different hosts. TMV is spread by physically handling diseased and then healthy plants. Cigarettes often harbor TMV so don't smoke when handling susceptible plants. TSWV is spread by thrips which are very small insects that are difficult to detect. Other insects such as aphids and leafhoppers can also spread viruses. Controlling plant-feeding insects in the greenhouse will help reduce the incidence of virus diseases.

Nematodes are small (one thirty-second to one quarter inch long) roundworms that are common inhabitants of field soil. Most nematodes are not parasitic on plants but prey on microorganisms, insects and other nematodes.

Shown here are rose leaves exhibiting symptoms of virus infection.

Plant parasitic nematodes may attack the root system, stem or foliage depending on the species of nematode involved. Root-knot nematodes (*Melodogyne* spp.) cause galls of various sizes (usually one sixteenth to one quarter inch) on the roots of a wide range of plants. The bulb and stem nematodes (*Ditylenchus* spp.) occur on hyacinth, narcissus, daffodil, tulip, and iris as well as other plants. Colonized bulbs may have necrotic areas and developing leaves have swellings and distorted growth. Foliar nematodes (*Aphelenchoides* spp.) attack the leaves and occur on bird's-nest fern, African violet, gloxinia, Rieger begonia, chrysanthemum, Boston fern, phlox, peperomia and India rubber plant. Symptoms caused by foliar nematodes may be easily mistaken for those caused by fungi or bacteria.

Plant Disease Control

Many diseases are not successfully controlled because the cause was not accurately determined. Thus, the first principle of disease control is to identify the cause of the problem. This may be done with the appropriate literature and experience but often technical help is necessary. Contact your local Cooperative Extension office, plant disease clinic or garden center for assistance.

The use of resistant cultivars (varieties) is the ideal way to control diseases. Vegetable seed is usually designated as resistant to *Verticillium*, *Fusarium*, and root-knot nematode (or V, F, and N respectively). Resistance to other pathogens is available but limited. Check with your seed supplier or catalog for resistant cultivars.

Sanitation and cultural practices are among the most important ways to prevent and control plant diseases. Sanitation is a general term for the removal of diseased plant material and for the surface disinfection of tools and working surfaces. When disease occurs, affected plants or plant parts should be removed and taken away from the greenhouse. Do not discard plant material under the bench. Plant litter should be periodically removed from the floor. Used pots, flats and tools should be washed free of soil and treated with a 1:9, Clorox:water, solution. Metal surfaces should be rinsed with water after treatment with Clorox to prevent rusting. Wooden structures and flats can be treated with copper naphthalate.

Sound cultural practices include the use of a pathogen-free growing medium with desirable physical qualities for the crop to be grown, proper regulation of water, fertilizer, temperature and humidity, and proper planting techniques. A continual effort must be made to avoid recontamination of the growing medium. Soilless media (peat/perlite/vermiculite and other nonsoil mixtures) do not have to be treated before use. However, a preventative application of one or more fungicides is desirable for plants that are prone to damping-off or root rot. Soil from out-of-doors, whether used by itself or as an amendment in a soil-less medium, must be treated to eliminate soil-borne plant pathogens, insects and weeds. Hose nozzles which contact the floor or other soiled surfaces can effectively contaminate the growing medium with root rot pathogens. Provide a hook on the wall to hang up the hose.

Overwatering displaces oxygen in the soil resulting in an unhealthy root system and at the same time providing favorable conditions for root rot organisms such as the fungi *Pythium* and *Phytophthora*. Also, when soil remains cold and wet, ammonium,which is a fertilizer constituent, can build up to toxic levels. Overfertilization can directly damage roots and also increase the severity of *Pythium* root rot. Have the growing medium tested periodically for ammonium and soluble salt levels.

The avoidance of high humidity and condensation of water on plants is essential for controlling *Botrytis* blight as well as other foliar diseases. High humidity is most prevalent during spring and fall. As the sun sets, temperatures fall and the relative humidity increases until the dew point is reached. Humid, wet conditions provide an ideal environment for spore germination and infection of plant tissues. To reduce humidity, evacuate the air from the greenhouse to allow the cool night air to come in. Raise the temperature several degrees and the relative humidity will decrease. Proper spacing of plants on benches, watering in the morning and circu-

Bacterial blight of geranium is exhibited here by leaf spots. The bacterium eventually becomes systemic and kills the plant.

lating air with fans will also help reduce humidity within the plant canopy and thus help reduce diseases. An humidistat would be a wise investment.

Fungicides can provide excellent control of some diseases but for others they may be ineffective, unavailable or illegal. When purchasing and using fungicides one must know which fungi are to be controlled, whether the fungicide is labeled for greenhouse use and if it is the appropriate formulation for the application methods at hand. Do not rely on fungicides alone. A holistic approach to plant disease control is encouraged.

Common Diseases in the Greenhouse

Damping-off

Damping-off is a disease of young seedlings caused by soil-borne fungi. Affected plants collapse and may have root rot, stem lesions at the soil surface or both. Flats of seedlings often damp-off in a circular pattern because fungi grow radially from the point of origin. Hot water from heat-baked pipes and hoses, excessively hot or cold temperatures and overfertilization can mimic symptoms of damping-off. To control damping-off, it is essential to sow seeds in a pasteurized growing medium and to avoid overwatering and contamination with untreated soil. For particularly susceptible plants, use fungicide-treated seed or incorporate the appropriate fungicide into the medium at planting time.

The characteristic sign of Botrytis *blight on poinsettia is the appearance of a grey mold on the infected tissue.*

Root Rot

Root rot is a destructive disease caused by several soil-borne fungi. Occasionally soft rot bacteria and plant pathogenic nematodes are involved. Healthy, actively growing feeder roots are white to light brown and firm. Diseased roots may have one or more of the following symptoms: water-soaked appearance, brown or black lesions, soft-rotting of the tissues and "rat-tailing," a condition where the outer cortex of the root sloughs off leaving a protruding resistant core (Fig. 1). Once above-ground symptoms of wilt occur, the disease has progressed too far and the plant cannot be saved. Since an

unhealthy root system is not generally apparent until wilting occurs, every effort must be made to prevent root rot from occurring. Use a pathogen-free growing medium, avoid contamination and apply water and fertilizer as needed. Fungicides can be used to protect particularly susceptible or valuable plants but they will not cure existing disease. Contact your local Cooperative Extension floriculture specialist for specific pesticide recommendations.

Botrytis Blight

Botrytis blight is caused by the fungus *Botrytis cinerea* and is one of the most important diseases in greenhouses. It can attack flowers, foliage and stems of a wide variety of plants. A characteristic sign of Botrytis blight is the appearance of a grey mold on the affected tissue. Optimum conditions for Botrytis spores to germinate and infect plants occur when the air temperature is 45 to 60 °F, free moisture is present on plant surfaces for eight to 10 hours and humidity is 93% or greater. Disease development and spore production are favored by temperatures between 68 and 75 °F. Botrytis blight is prevalent during spring and fall because that is when favorable conditions in the greenhouse are most likely to occur. Thorough sanitation will help to control Botrytis blight. Remove all plant debris and dead flowers. Heat and ventilate during periods of high humidity, space plants adequately and provide air circulation. Several fungicides are available for controlling this disease.

Powdery Mildew

Powdery mildew occurs on many different greenhouse plants and is especially important on begonia and rose. The disease is evident on the upper surface of the foliage as a white, mealy appearing deposit. The symptoms are the result of a crop of spores, which, on some hosts, may be fairly sparse and thus overlooked. Since the fungus only colonizes the upper layer of leaf cells, severe damage to the plant does not usually occur. An exception is begonia which can be severely damaged. The superficial growth habit of the fungus makes it one of the few diseases where application of the appropriate fungicide makes eradication possible.

Bacterial Diseases

As mentioned earlier, bacteria can cause many different diseases with symptoms similar to those caused by fungi. Soft rot of corms, bulbs, rhizomes and cuttings is often caused by bacteria. Soft rot is evident by a mushiness of the affected tissues and often a foul-smelling odor. The disease usually occurs under conditions of excessive soil moisture. Wounding of tissues by improper handling or by insects can also be important. Cyclamen corms that are buried too deeply are subject to decay. Soft rot cannot be controlled with pesticides. Avoid wounding and overwatering.

Several bacterial blights occur on begonia, chrysanthemum, geranium, poinsettia and bedding and foliage plants. In some cases bacterial diseases are seed-borne or present when the plants were purchased. Some plant pathogenic bacteria may be permanent residents within the greenhouse. Bacterial blights are spread by handling diseased plants, splashing irrigation water and by vegetative propagation from diseased plants. Depending on the bacterium involved, it may eventually destroy the plant or it may be of a minor consequence. If the plant material is valuable, a diagnosis by a specialist should be made. To control bacterial blights, buy seed from a reputable source, inspect plants for lesions before bringing them into the greenhouse, remove diseased plants from the greenhouse and avoid wetting the foliage during irrigation. Bacterial blight cannot be effectively managed with pesticides.

Fusarium and Verticillium Wilt

Fusarium and *Verticillium* are soil-borne fungi that cause vascular wilts of plants. Symptoms include leaf yellowing and wilting, often on one side of the plant. A cut into the stem base will often reveal a discoloration of the vascular tissue. *Fusarium* and *Verticillium* are not often a problem in greenhouses; however, they can be a problem when unpasteurized field soil is used to grow susceptible plants. Occasionally plants are purchased that have vascular wilt disease and symptoms may not show up for several weeks. Discard affected plants. Use a pasteurized growing medium. ⊠

An Alternative Method to Chemicals: Biological Control

L.J. Dupre

Too often, we equate pest control with killing insects, but the purpose of pest control is to prevent the damage that insects cause and to preserve plant or crop quality.

When establishing your own program, it is crucial to understand how pest problems become epidemic. Study the relationship of H (Host), E (Environment) and P (Pest). The area where all three overlap is I (Infestation). Think of all three as dynamic.

Small areas of overlap by all three denote minor infestations; total or near total overlap means an epidemic and possible plant death. Pest control means manipulating H, E and P to eliminate or reduce I so any damage is tolerable.

An actively growing, healthy plant generally resists diseases and is not attractive to insects. Plants under stress are vulnerable to insect infestations. Plant stress may be caused by too much or too little water, air, heat, light, soil pH or incorrect fertilization. In addition, a greenhouse environment provides ideal conditions for pest growth and development. In that artificial environment, insects, diseases and weeds can proliferate.

If an insect problem arises, it is important to begin by identifying the cause. Examine the infested plant carefully. You will find a hand lens helpful for finding mites, small insects and eggs. Once you have identified the problem, you are ready to seek solutions.

An excellent place to begin is by calling your local Cooperative Extension Office listed in the phone book under "County Gov't." Horticultural Agents or trained Master Gardener volunteers on the staff will help you identify problems and offer advice on corrective measures. The following general suggestions might help to control infestations.

By far the simplest method of pest control is to exclude outdoor pests by covering your greenhouse vents with a fine mesh screen while also keeping the door closed or using a screen door.

Insects are attracted to bright yellow objects. Sticky yellow lures are very effective for catching winged, soft-bodied insects. Paint thin pieces of plywood (6" x 12") bright yellow, coat thinly with Tanglefoot, Tacktrap, petroleum jelly or oil and hang or stake near your plants. Clean and recoat the lure as needed. Similar traps are often sold at garden centers.

Brewed coffee or tea also controls certain insects. However, the brew must have caffeine—decaffeinated beverages won't work.

Rubbing alcohol applied with a cotton swab or sprayed directly on the insect will help control mealybugs and scale insects.

Also effective are botanical preparations which include plant-derived poisons such as

L.J. Dupre of Anacortes, WA retired after 30 years in the U.S. Navy and then turned his talents to gardening. He has been a master gardener for 13 years and writes a weekly column for a local newspaper.

Photo by Anna Edey

Strong, healthy, actively growing plants resist insect infestations and generally are not attractive to insects. If insects appear, it is important to identify the cause.

pyrethrins, rotenone, nicotine, ryania, sabadilla, and hellebore. They can be obtained locally or via mail order.

Both Safers, Inc., 60 William St., Wellesley, MA 02181 and Reuter Laboratories, Inc., 1400 Ford Building, Detroit, MI 48226 produce natural pesticides to control insects and diseases. Write to them for information and availability of their products.

Finely ground dusting sulfur is also relatively safe for controlling fungal diseases.

Beneficial predatory or parasitic insects are available via mail order. Predators eat their prey while parasites lay their eggs in the eggs or bodies of other insects. Parasitic nematodes control damaging nematodes and insects which spend part of their life in the soil, although they do not harm earthworms. However, bear in mind that most beneficial insects are very specific about their host and so the pest to be controlled must be positively identified.

New botanicals are being tested and will shortly enter the supply pipeline. The neem tree *(Azadirachta indica)* of S.E. Asia has insecticidal properties and is being investigated. In addition, a broad spectrum insecticide derived from the American pawpaw tree has been patented. Beneficial molds to control disease problems have been isolated by USDA scientists.

Perhaps the most promising recent discovery is *Bacillus thuringiensis*. Almost 100 strains of this bacterial insecticide are being investigated as controls for a wide variety of insects including mites and beetles.

To keep abreast of the latest developments in the field, look under "Biological Control" in the classified advertisement section of gardening magazines. ▩

For further reading try:

Hussey, N.W. & Scopes, N.—editors. *Biological Pest Control, The Glasshouse Experience.* Ithaca, NY: Cornell University Press.

Cook, R. James and Baker, Kenneth F. *The Nature and Practice of Biological Control of Plant Pathogens.* American Phytopathological Society.

Ware, George W. *Complete Guide to Pest Control With and Without Chemicals.* Thomson Publications.

Putting Biological Control into Action

Anna Edey

Insects have always been with us. Over 900,000 species are known to exist, and there may be twice that number not yet discovered. Approximately 99% of all insects are beneficial to mankind (insect-eaters, pollinators, aerators, composters, etc.). However, there are some insects that are considered to be harmful.

Since ancient times people have tried various methods of protection against insect infestations, but pests have remained a major problem all over the world. Solutions were sought in the form of chemical pesticides. However, we now know the disastrous consequences of relying on "miracle cures." Many people are seeking more lasting solutions which lie in developing an understanding of ecological balance and coexistence.

That is what I set out to do when I started my 3000-square-foot solar greenhouse, the Solviva Winter Garden, in 1983. I wanted to demonstrate the feasibility of producing abundant quantities and varieties of the highest quality vegetables, herbs and edible flowers year-round. And I wanted to accomplish this without causing pollution and depleting precious resources in a climate where the temperature can hover around 0° F for days, and the sun can remain hidden for weeks. In addition, I wanted to

The author's 3,000-square-foot solar greenhouse has been in continuous operation for four years. No back-up heat is required.

Anna Edey of Martha's Vineyard, MA is the founder, designer and director of Solviva Winter Garden.

Tomatoes are growing on vines along with other vegetables in benches and hanging above the benches. Plants are checked frequently for any problems.

demonstrate that this could be a financially viable business.

I am happy to report that after four years of continuously operating this solar greenhouse as an organic, high-yield year-round food garden, my hopes and dreams have not only been reached, but they have been greatly exceeded.

The solar operation is accomplished by combining the sun's energy with animal heat. Sufficient heat is maintained throughout the winter by the storage of solar heat in about 4,000 gallons of water, combined with the body heat of chickens and angora rabbits living in enclosures within the well-insulated greenhouse. The animals also provide manure compost for soil enrichment. No back-up heat is required, even in the worst weather conditions. Natural ventilation cools the greenhouse in summer without the need of electricity. Photovoltaic panels and batteries power the circulating fans and working lights.

In the solar greenhouse, the insect management is unusually effective, easy and low-cost. Most importantly, it is absolutely non-toxic. Here is an eight-point program for success:

1) Introduce and maintain a variety of beneficial insects some of which come in from outside (such as syrphid flies, chalcid wasps, tachinid flies and braconid wasps); combined with insects that are brought into the greenhouse (such as *Aphidoletes aphidimyza*—aphid parasite, praying mantis, etc.); and some insects that I order from Rincon-Vitova, an insectary in Oak View, California (such as *Encarsia formosa*—greenhouse whitefly parasite, ladybugs, lacewings, predatory mites, etc.).

2) Grow a multitude of nectar-producing flowers such as dill, parsley, fennel, cilantro, and alyssum from which the beneficial insects draw supplemental nourishment.

3) I maintain maximum plant health by good management of soil, air, temperature, sanitation and harvesting in order to resist insect attacks. A healthy plant has a strong cell structure and is harder for insects to penetrate than a weak one.

4) I grow many nasturtiums as host plants. Not only are nasturtiums beautiful, edible and nutritious, but they thrive in the darker areas of the greenhouse where few other plants would be productive. Of all the 200 or so different varieties of plants in the greenhouse, the nasturtiums are most attractive to aphids, whiteflies, thrips, spider mites and leafminers. Therefore, they also furnish excellent habitats for the beneficial predatory and parasitic insects.

5) I monitor the situation. While watering or harvesting I constantly check the ratio of "good guys" to "bad guys." When necessary, I take action to keep the situation in the proper balance.

6) I leave many insect infested plants standing. This principle is the most difficult for visitors to understand. However, the weakened plants will attract harmful insects more than their healthy neighbors. If I pulled plants as soon as they got pest infested, I would interrupt the reproductive cycle of many of the parasitic insects. Infested plants are important insectaries.

7) I trust that harmony will prevail. This means that I do not intervene to eradicate the "bad guys," not even with insecticidal soap. If an insecticide is meant to kill or harm, it would certainly do the beneficials equal damage either directly or as they interact with the poisoned pests.

8) I do some hand-picking and trapping. Slugs and caterpillars can be a nuisance, and are the only critters I spend any time controlling. Slugs are best hand-picked at dawn or dusk, or trapped in small containers pressed into the soil and filled with beer, or collected from rotting pieces of wood under which they hide during the day.

However, after four years of trying to control caterpillars by hand-picking with unsatisfactory results, I recently decided to use Dipel (*Bacillus thuringiensis*). Not only did it work well, but it is reputedly non-toxic to anything but leaf-eating caterpillars.

From time to time, there are rushes of aphids, spidermites or whiteflies. I hang on faithfully, allowing some of the lettuce to be overcome by aphids, watching in suspense as the beneficials increase in number. I go around with my 10 X magnifying lens, checking the progress and carefully distributing the beneficials to places in most need. As we harvest, we remove them and place them back into the greenhouse.

Research is rapidly progressing all over the world to find a biological control for every single pest, making it possible to achieve high food production without the use of any toxic chemicals. However, we are just beginning to discover the possibilities in biological control. There are some real challenges out there, not all of which are food related, such as wool moths, fleas, ticks and mosquitos.

Many people think of food crops as being riddled with pests which must be controlled with poisons. Therefore they assume that they cannot possibly grow foods in their home-attached greenhouses without endangering members of their household. The Solviva Winter Garden is living proof that it is possible to grow food safely in a greenhouse that is fully incorporated into a home. ⊠

Suppliers of Beneficial Organisms in North America

Excerpted from a list by Larry Bezark and Helen Yee of the State of California Biological Control Services Program
3288 Meadowview Road
Sacramento, CA 95832

The following companies list several beneficial organisms that may be helpful to greenhouse growers:

Bio Insect Control
710 S. Columbia
Plainview, TX 79072

Harmony Farm Supply
P.O. Box 451
Graton, CA 95444
free catalog

King's Natural Pest Control
224 Yost Avenue
Spring City, PA 19475
free literature

Mellinger's Nursery
2310 W. South Range Road
North Lima, OH 44452
free catalog

Natural Pest Controls
8864 Little Creek Drive
Orangevale, CA 95662
free brochure

Necessary Trading Company
P.O. Box 603
New Castle, VA 24127
charge for catalog

Organic Pest Control Naturally
P.O. Box 55267
Seattle, WA 98155
charge for catalog

Peaceful Valley Farm Supply
11173 Peaceful Valley Road
Nevada City, CA 95959
free catalog

Rincon-Vitova Insectaries, Inc.
P.O. Box 95
Oak View, CA 93022
free brochure

Camellias thrive in the cool greenhouse at the Lyman estate. These plants are over 100 years old.

Greenhouse Magazines and Sources

Reprinted by permission of the Indoor Citrus Society from the Summer 1987 issue of Indoor Citrus and Rare Fruit Society newsletter.

Magazines

Greenhouse Grower—published monthly by Meister Publishing Co, 37841 Euclid Ave., Willoughby, OH 44094.

Greenhouse Manager—published monthly by Branchsmith Publishing, 120 St. Louis Ave., Ft. Worth, TX 76104.

Hobby Greenhouse—published by the Hobby Greenhouse Association, 8 Glen Terrace, Bedford, MA 01730.

Greenhouse Sources:

Below are companies that sell greenhouses, compiled from lists from *Hobby Greenhouse Magazine, Greenhouse Manager Buyers Guide* and Barbara Barton's book *Gardening by Mail.*

Hobby Greenhouse:

Eden—Northwest Eden Sales, Inc., 15103 NE 68th St., Redmond, WA 98052

English Cottage Greenhouse—Smith & Hawken, 25 Corte Madera, Mill Valley, CA 94941

Santa Barbara Redwood—Charley's Greenhouse Supplies, 1569 Memorial Highway, Mount Vernon, WA 98273

Hoop House Greenhouse—Fox Hill Farm, 20 Lawrence St., Rockville, CT 06066

Sun-Lite Greenhouse—Solar Components Corp., P.O. Box 237, Manchester, NH 03105

Northern Light Greenhouse—Gardener's Supply Co., 133 Elm St., Winooski, VT 05404

Halls Greenhouse—W. Atlee Burpee Co., Warminster, PA 18974

Greenhouse Manager: (M manufacturer, W wholesaler, D distributor.)

A&P Ag Structures (M), 11266 Ave. 264, Visalia, CA 93277.

ADJ Horti-Projects Inc. (M), Box 3004, Langley BC, Canada V3A 4R3.

Agro Projects (M), 7114 Pomelo Dr. 1, Canoga Park, CA 91307.

Aluminum Greenhouses, Inc. (M), Box 11087, Cleveland, OH 44111.

Anderson Orchids, 2059 Lee Rd., Smyrna, GA 30080.

Atlas Greenhouses, 117 Wakefield, Hampton, CT 06517.

B.F.G. Supply Co. (W), 14500 Kinsman Rd., Burton, OH 44021.

Ball Seed Co., Box 335, W. Chicago, IL 60185.

Beck Greenhouse Co. (M), Box 650, Auburn, AL 36830.

Carson & Associates, Cliff, 204 Forest Dr., Greenwood, SC 29646.

Clover Greenhouses By Elliott Inc. (M,W.), Box 789, Smyrna, TN 37085.

D.A.C.E. Inc. (M), Box 475, Port Jefferson, NY 11776.

DeCloet Ltd. (M), Box 145, Tillsonburg, ON, Canada N4G 4H3.

Double A Truss Mfg. Co. Inc. (M,W,D), 320 Wetmore, Manteca, CA 95336.

Geiger Corp. (W,D), Rt. 63, Box 285, Harleysville, PA 19438.

Growers Intl. Inc. (W), Box 10, Schulenburg, TX 78956-0010.

Harnois Industries, (M,W) 1044 Main. St. Thomas of Joliette, PQ Canada, JOK 3LO.

Hydro-Gardens Inc., Box 9707, Colorado Springs, CO 80932.

Landreth Nursery Co., 1000 Far Shores, Hot Springs, AR 71913.

Lord & Burnham (M), Box 255, Irvington, NY 10533.

Ludy Greenhouse Mfg. Corp., Box 141, New Madison, OH 45346.

McAllister Co. Inc. (M,D.), Box 6667, Burbank, CA 91510.

Nexus Greenhouse Systems Corp. (M), 10983 Leroy Dr., Northglenn, CO 80233.

Northern Grower Systems Inc. (M), 1550 E. Shore Dr., St. Paul, MN 55106.

Pacific Coast Greenhouse Mfg. Co., 83600 Industrial Ave., Cotate, CA 94928.

Prins Greenhouses, 201 Maison St., Elmhurst, IL 60126.

Rough Bros. Inc. (M), Box 16010, Cincinnati, OH 45216.

Serac Ltd. (M), Box 2186, Davis, CA 95617.

Smith Inc. (M), Drawer X, Box 272, Red Bank, NJ 07701.

Stuppy, Inc., Box 12456, N. Kansas City, MO 64116.

V&V Noordland, Inc., Box 739, Medford, NY 11763.

VEBO Ltd. (M), 196 Belleview Ave., Center Moriches, NY 11934.

Van Wingerden Greenhouse Co., (M), 4078 Haywood Rd., Horse Shoe, NC 28742.

Vary Industries (M), Box 248, Lewiston, NY 14092-0248.

Winandy Greenhouse Co. Inc., 2211 Peacock Rd., Richmond, IN 47374.

Zethof Greenhouse Services Inc., Box 331, Wellington, OH 44090

(Check *Greenhouse Manager's* **All-Industry Buyer's Guide Product Directory,** Spring 1987, for additional manufacturers.)

Gardening by Mail:

Gothic Arch Greenhouses, P.O. Box 1564, Mobile, AL 36633-1564.

House of Redwood, 2910 E. Blue Star Ave., Anaheim, CA 92806.

Santa Barbara Greenhouses, 1115 Ave. Acaso #J, Camarillo, CA 93010.

McGregor Greenhouses, 1195 Thompson Ave., Santa Cruz, CA 95062.

Machin Designs (USA) Inc., P.O. Box 167, Rowayton, CT 06853.

Bloomin' Greenhouse, Inc. 7591 Wilson Blvd., Jacksonville, FL 32210-3535.

Suncraft, Inc., 414 South Street, Elmhurst, IL 60126.

Janco Greenhouses, 9390 Davis Avenue, Laurel, MD 20707-1993.

Turner Greenhouses, P.O. Box 1260, Goldsboro, NC 27530-1260.

Sun System Greenhouses, 60-D Vanderbilt Motor Pkwy., Commack, NY 11725.

Four Seasons Greenhouses, 425 Smith Street, Farmingdale, NY 11735.

Vegetable Factory, Inc., 71 Vanderbilt Avenue, New York, NY 10169.

Aluminum Greenhouses, Inc., P.O. Box 11087, Cleveland, OH 44111-2140.

Cropking Greenhouses, P.O. Box 310, Medina, OH 44258.

Sturdi-Built Mfg. Co., 11304 S.W. Boones Ferry Rd., Portland, OR 97219.

Texas Greenhouse Co., 2723 St. Louis Ave., Ft. Worth, TX 76110.

Sunglo Solar Greenhouses, 4441 26th Ave. West, Seattle, WA 98199.

This Cattleya *hybrid continues to thrive although it has outgrown the clay pot. Ideal greenhouse conditions make it possible for epiphytic orchids to thrive even though repotting is overdue.*

Photo by Charles Marden Fitch

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Greenhouses & Garden Rooms

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PLANTS & GARDENS
BROOKLYN BOTANIC GARDEN RECORD

GREENHOUSES & GARDEN ROOMS

THIS HANDBOOK IS A REVISED EDITION OF PLANTS & GARDENS, VOL. 44, NO. 2

HANDBOOK # 116

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A section of the orchid collection at Golden Gate Park Conservatory is displayed with ferns.

FOREWORD

Tovah Martin

For people who love plants, one of life's pleasures is to provide their collection with the perfect environment. Sometimes, ideal conditions are available outdoors. But, when this is not the case, gardeners turn to greenhouses and garden rooms to furnish the warmth, light and humidity that plants require.

Many gardeners dream of having a greenhouse. And that goal becomes increasingly easy to achieve as greenhouse technology advances and more systems appear on the market. Greenhouses come in all shapes and sizes. They can be added to the window of a city apartment or stand separate from the house. There is a greenhouse for every gardener.

Our goal in this handbook is to introduce you to the various types of greenhouses and garden rooms and to help you choose which is appropriate to your purposes. We have described some of the mechanical workings of a greenhouse so that you can heat, cool, ventilate and shade your structure efficiently. And, knowing that many of you are planning to grow a specific crop in your greenhouses, we have described greenhouses for cut flowers, orchids, winter-forced bulbs, and cool-loving plants. This handbook also presents ideas for plant maintenance in the greenhouse environment. Finally, because problems will occur, we have covered pest and disease management in the greenhouse.

A Little Background

THE GREENHOUSE'S ROOTS

Tovah Martin

Greenhouses are not modern inventions. There is written evidence that the Romans fashioned transparent structures for the protection of rare, tender fruit off-season. Those buildings were called *specularia* and they were glazed with thin sheets of talc and mica. In addition, they were heated by amazingly sophisticated stove and flue systems.

Although artificial environments for protecting plants against the elements have had many critics over the centuries, man has continued to build and to perfect glass structures. In the 17th century, *orangeries* came into vogue in Europe. These glass-sided buildings were constructed specifically to protect citrus, the fruit of kings, thus allowing royalty the luxury of enjoying juicy sweet fruit off-season. However, *orangeries* were heated either by primitive stoves that required constant attention or by steaming manure piles.

With the dawning of the 19th century, greenhouse technology took flight. In 1845 excise taxes on glass were lifted. Before long glass-making processes were revamped, making glass inexpensive, readily available and of good quality. At the same time tropical plants were arriving in Europe from the temperate regions of the globe. Gardeners struggled to develop glass structures that were sufficiently sophisticated to shelter this magnificent tropical plant life. They set to work studying slopes, calculating positions, as well as inventing efficient furnaces and piping systems. Greenhouse construction took a giant leap forward.

But greenhouses were expensive to construct and maintain. That situation was not destined to change overnight. Finally, by the middle of the 19th century, prefabricated greenhouses appeared. They were common on the European market by the 1880s.

In North America, we have some unique environmental problems with which to contend — for one, a severer winter climate than in Great Britain. Throughout most of the 19th Century, we trailed behind Europe in the construction of greenhouses. Finally, Frederic A. Lord happened upon the scene. Lord built his first greenhouse in the frigid city of Buffalo in the mid-1850s and from then on he labored to perfect stoves that would maintain greenhouse temperatures despite sub-zero outdoor temperatures. Apparently, he was successful. By the 1870s, his greenhouse building business was so brisk that Lord took his son-in-law, William Burnham, into partnership.

We've come a long way since those early greenhouses and we undoubtedly have a good distance to travel until greenhouse technology has reached its pinnacle. However, we owe a debt of gratitude to the first gardener who decided that he must have fruit despite the weather outdoors.

Tovah Martin *is staff horticulturist at Logee's Greenhouses and the author of* ***Once Upon a Windowsill*** *published by Timber Press, 1988.*

SELECTING A HOBBY GREENHOUSE

JOHN W. BARTOK, JR.

A hobby greenhouse will allow you to enjoy gardening when the weather outside is too cold for growing plants. When deciding on a greenhouse an important consideration is how it will be operated.

The season-extender greenhouse is used primarily to extend the growing season by a few weeks in the spring and fall. Garden vegetables and bedding plants can be started earlier in the spring and flowering plants kept in bloom later in the fall.

For year-round operation some supplemental heat is needed. If a cool greenhouse is operated to grow leafy vegetables or overwinter ornamental shrubs, it can be a small auxiliary heater. For most flowering plants a system capable of optimum temperatures is needed.

A greenhouse or sunspace attached to the house can be used as an extension of the living space or as a solar collector if designed properly. An orientation to the south is preferred. If operated as a greenhouse it has the advantages of convenient access and nearness to water and electricity.

Freestanding greenhouses are generally more expensive but allow greater flexibility than attached styles because they can be larger and located to receive more sunlight. Many different shapes are available.

The pit greenhouse, built partially below ground, uses the earth to keep it cool during the summer and warm during the winter. Strong walls to withstand the soil pressure and adequate floor drains are needed.

Size

Usually available space and cost, more than need or desire, dictate greenhouse size. When choosing a size, ask yourself how you will use the greenhouse. Are you really an avid gardener that has the time to care for the plants. If you are only starting a few seedlings for the summer garden, perhaps a hotbed is a better choice.

A minimum size for a hobby greenhouse is 8'x12' or 10'x10'. This gives enough room for benches and a work aisle. Eave height of gable-roof houses should be at least five and one-half feet and ridge height at least eight feet.

Frame and Foundation

Aluminum or galvanized metal frames are attractive and require little maintenance. To reduce heat loss some metal frames have thermal breaks. A wood frame is often the first choice of the do-it-yourselfer. Wood is easy to work with and costs less than other materials. Pressure-treated material should be used where it is in contact with the ground or for benches. It will last 25 years or more.

JOHN W. BARTOK JR., *Storrs, CT is an extension professor and extension agricultural engineer at the University of Connecticut. He is also a monthly columnist on greenhouse construction and maintenance for* ***Horticulture*** *magazine and* ***Greenhouse Manager*** *and has authored or coauthored four books, the most recent being* ***Greenhouse Engineering.***

An attached greenhouse opening into the house can become a garden room — a space for people as well as plants. PHOTO BY GEORGE TALOUMIS

Do not use wood treated with creosote or pentachlorophenol because it releases vapors harmful to plants.

Plans for wood frame hobby greenhouses are available from the Agricultural Extension Engineer at your Land Grant University. If you own and like to use a few basic hand tools, you may want to purchase a greenhouse kit. All the materials for the structure except the foundation are usually included. The names of local greenhouse suppliers can be found in the phone book business pages.

All greenhouses should be anchored to a solid, level foundation. Concrete, concrete block or brick are commonly used. Pressure treated posts set 18 inches or more in soil or concrete make a simple, low-cost foundation for a wood frame greenhouse.

Several inches of gravel or pea stone should be used on the floor for drainage. Brick, flagstones or concrete make a good walkway.

Benches and Beds

Benches raise the plants to a convenient working height. A standard height is 30-32 inches. Side benches should be two or

three feet wide and center benches may be as wide as six feet. Growing beds can be built as movable boxes or fixed permanently to the greenhouse floor. Frequently a ground-bed is located along the south sidewall to reduce shading of plants in the rest of the house. Pipes or wires above benches can hold hanging plants.

Glazing

Of primary importance in growing plants is the amount of light energy available for photosynthesis. This is especially true in northern latitudes during the winter when the sun angle is low and the daylength is short.

Glass is still the most common glazing for hobby greenhouses. Its clean appearance and transparency adapt well to today's homes. With larger panes available (up to four feet by seven feet) more light gets into the greenhouse. Low-cost tempered sliding-glass-door replacement panes make excellent glazing for custom built greenhouses. Bar caps and strip caulking material have reduced installation labor. The use of double wall tempered glass reduces heat loss by about one third. The additional cost of low iron glass is usually not cost effective even though light levels are increased by two to three percent.

Polycarbonate structured sheets are available in several thicknesses from four to 16mm. Normally seven to eight millimeters is used for hobby greenhouses. To insure long weatherability and durability purchase a co-extruded or coated polycarbonate sheet. These sheets will yellow less than an untreated material. Polycarbonates also have less flammability and higher impact resistance to hail or vandalism than the acrylic materials. For example, a six millimeter sheet will take a blow from a 10 pound steel ball dropped seven feet without cracking.

Acrylic structured sheets are available in eight and 16 millimeters thick sheets. Although they've been in use in the U.S. for only 10 years, a similar single-skin material — plexiglas — has been around much longer. This material does not yellow with age. Plexiglas is used in place of curved pane glass and in areas that might be subject to breakage.

Improvements in film plastics are still coming out of manufacturers research centers. Increases in strength, clarity, life and energy conservation are recent developments. Because most films do not have as long a life as rigid glazings, they are not used as frequently for hobby greenhouses.

The stronger co-polymer plastics called "greenhouse plastics" will give good service for two to three years. These can be purchased with an infrared radiation inhibitor that reduces the heat loss from inside the greenhouse by up to 20 percent on a clear night. Monsanto calls theirs "Cloud 9" and FVG America has named theirs "Sunsaver." Although the light transmission is the same as other greenhouse grade plastic films, the cloudy appearance diffuses the light.

Window Greenhouse

A window greenhouse is a good choice where you have limited space and time for gardening. A south facing window is best but windows facing east or west can also be used.

The window to which your greenhouse is attached must be the double hung casement type (opening up and down) or one that slides sideways because the plants must be accessible from the inside. Because the window greenhouse contains such a small volume of air, more attention to heating and cooling needs is required.

All types of greenhouses can give many hours of relaxation and enjoyment. The most common complaint is that it gets too small too quickly.

WINDOW GREENHOUSES

LINDA YANG

Apartment gardeners go to great lengths to keep their houseplants happy. This includes altering their homes to suit their plants. One major modification is a window greenhouse, which can also be an attractive extension to a room.

The idea for the first commercially produced window greenhouse is believed to have originated about 25 years ago when Cyrus D'Amato was preparing to display patio doors at the New York Flower Show. To make his glass products more appealing, he carved an opening in the wall of the display trailer and filled it with a "glass box" of plants.

He noticed that the visitors to the show were more intrigued with the box bursting with blooms than the storm doors he was trying to sell them. And so, the window greenhouse was born.

Mr. D'Amato's design was the inspiration for Lord & Burnham's Jiffy Window Greenhouse which has sold well over the years and has recently been revised to feature double insulated glass. The 17-inch-deep units are constructed of aluminum and can be purchased in varying widths (36" to 72") and heights (36" to 72"). With the option obtaining additional shelves for the units, Lord & Burnham advertises that their window greenhouses provide plenty of room to grow.

It was to Lord & Burnham that Kurt Munkacsi turned when his dozens of cactus plants overgrew his windows. A New York City based recording engineer and record producer, Mr. Munkacsi's involvement with houseplants began innocently enough when a friend gave him a tiny *Lithops*. Fascinated by that succulent, he continued to buy them by the score. The growing space dwindled in the downtown loft that is his home and office and a window greenhouse seemed the way to grow. His succulent collection is now comfortably accommodated in an arid window greenhouse.

Pat Beadle, a production manager with a film company, bought her unit to provide a humid atmosphere for her scores of orchids, begonias and ferns. Her husband assumed that the greenhouse would ensure that her bulging collection would be confined to one place. But Mrs. Beadle has used her unit to propagate even more plants, distributing them to other sills. Her husband,

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accepting the inevitable, devised mesh screen doors that separate the greenhouse unit from the room and keep their cats from jumping into propagating trays.

Although these two city gardeners employ their window greenhouses to provide completely different climates, the unit they use is basically the same. And they both faced similar installation problems. The installation charges are usually extra, but while it's not impossible to "do it yourself," it's not so easy in the city. Lord & Burnham suggests that a local contractor be used to help follow the instructions provided.

Projecting window greenhouse units are usually not a problem on city walls that are set back from the building line. But, if the unit is planned for an area where it will overhang the street, building department safety procedures must be followed. So it is best to check with your local authorities before you begin.

A typical installation for masonry buildings entails first fastening a wood frame to the outside walls with expansion shields and lag bolts. The greenhouse is then attached to this frame, completely surrounding the existing window, from which the sashes may then be removed.

For penthouse or brownstone residents, this may mean using a long ladder or scaffolding, or a cable from the roof to temporarily suspend the unit while it is being secured.

Mr. Munkacsi's situation was particularly challenging and his solution was logical and innovative. Since his loft is on a high floor and his window area is not accessible on the exterior from either below or above, he used a custom-sized unit that would fit through his window from inside the room. Friends in the stage construction industry fabricated a heavy aluminum frame that he used to replace the original wood window sashes. Working from indoors, he could then slide the greenhouse through the window opening and attach its sides directly to the inner faces of this new aluminum frame.

Both Mrs. Beadle and Mr. Munkacsi removed the original windows so their greenhouses open into the room and benefit from apartment heat. His houseplants require a dry environment, hers need humidity. Their window greenhouses have made it pleasurable for them to do just that.

Portions of this article first appeared in the Home Section of The New York Times.

GARDEN ROOMS FOR EVERYONE

OGDEN TANNER

Garden rooms are designed primarily for people, with an accent on comfort, outdoor views and the sun. PHOTOS BY GEORGE TALOUMIS

In recent years glass additions have become increasingly popular, not only as greenhouses for serious indoor gardening, but as rooms to live in, eat in, take baths in and almost everything else. In the pages of magazines, happy families are pictured using theirs in all sorts of mouth-watering ways: sunbathing in the dead of winter, breakfasting among potted palms, splashing merrily in hot tubs with wine glasses raised high, entertaining dinner guests by candlelight under a sky spangled with stars.

Call them sun rooms, solariums, garden rooms or whatever you like, these spaces differ from working greenhouses in one major respect: they are designed primarily for people, with the accent on comfort, outdoor views and the sun itself. While some decorative plants are usually part of the scene, they are supporting players, not the stars. Fortunately, there are many species whose basic needs for light, temperature and humidity do not conflict with those of human occupants.

Among other attractions, a prefabricated glass unit can be less expensive than a conventionally built addition, and can add at least its cost to the resale value of a house. Moreover, if properly designed, it can trap, store and distribute sun heat, sharing its warmth with the rest of a home and reducing household heating bills.

The ideal exposure for a garden room, like a greenhouse, is south for maximum winter sun. Southeast will provide welcome morning sunlight, and is a good choice for a breakfast room; a southwest exposure yields more afternoon sun and may provide a nice view of sunsets, but will require shading, especially in summer, against hot afternoon rays. Unlike a working greenhouse, a live-in glass addition can even be placed

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An enclosed breezeway using lots of glass becomes a garden room.

on the north side, though it will receive mostly indirect light and no solar heating, and will have to be furnished with plants that tolerate lower light.

The most practical shape for the average sun room is a rectangle with its length along the side of the house measuring about one and-a-half to two times its projecting width—the greater the glass area facing south the more sun it will get, and the greater the wall area the sun room shares with the house, the greater the potential for an exchange of solar heat between the two.

Manufacturers' units, which are generally cheaper than custom-built designs, come in a variety of choices, from a glorified bay window three-feet deep and eight-feet long, which can serve as a modest enlargement of an existing room, to a two-story solarium 20-feet deep and more than 50-feet long—big enough for an indoor swimming pool. A common tendency among budget-conscious homeowners is to order the smallest size they think suitable to their purposes, only to discover that the new space is used so much it doesn't seem big enough. Because of square-foot economies inherent in construction, installing a larger model can actually yield as much as 50 percent more space at only 25 percent more cost.

Units with wooden structural frames provide a substantial, natural-looking extension of a house, and can be stained or painted any color. Most manufacturers' models, however, are made of slimmer aluminum members, generally with dark bronze or white baked-enamel finishes that are virtually maintenance-free. The best units have secure seals against air and water leaks, thermal "breaks" to minimize conduction of heat (and cold) through the metal, and gutters to carry off condensation on the inside of the glass.

Rigid plastics can be used, particularly on roof sections and end walls, but for maximum light and views most sun rooms are enclosed in ordinary glass, which is highly transparent, scratchproof and durable. The annealed glass used today is strong enough to resist breakage under normal conditions, though many manufacturers recommend tempered or laminated glass, particularly for high-use areas and overhead glazing.

Double, and even triple, insulating glass is also available, and should be considered in northern areas to prevent heat loss on cold winter nights. A further option is glass treated with low-emissivity or "low-e" coating, which admits light and solar heat, then traps the heat by reflecting reradiation from objects inside. Besides being energy efficient, low-e glass can reduce condensation, block much of the ultraviolet light that fades indoor fabrics, and make the inside glass warmer to the touch.

One problem with a year-round, live-in glass addition is that it may get not too little sun but too much. Provisions should be made to shade the room in summer, by well-placed deciduous trees and/or by screening devices like roll-down blinds, which are sold by most manufacturers. (Some offer units with motorized blinds that run on tracks, or narrow, adjustable louvers that are actually sandwiched between two layers of insulating glass.) Bronze-tinted reflecting glass, which cuts light and heat transmission drastically, may be a desirable option in locations where there is excessive heat or glare, though it may limit plant growth and the color quality of the light inside does not appeal to everyone.

To provide permanent shade, and more efficient insulation against winter cold, some solarium units eliminate overhead glass entirely by using a solid, sloping roof with an overhang, or reduce the amount of glass by piercing a solid roof with individual skylights. A well-

designed space of this kind blocks high summer sun but allows low winter rays to penetrate and warm the room, and is often used in energy-efficient solar designs (described below).

In addition to shading, adequate ventilation is vital for both people and plants. If possible, doors and windows should be placed to capture cross-drafts from prevailing summer breezes; this natural flow can be aided by an exhaust fan high on one end wall, with pivoting intake louvers on the opposite wall. Adjustable vents along the roof line, either hand-operated or automatic, may also be desirable to release a buildup of heat at the top of the room. A slowly rotating ceiling fan will provide a gentle, constant movement of air, mixing layers of different temperatures, and in winter bringing warm air down from above.

The flooring in any sun room that gets constant use should be durable, moisture-proof and easy to keep clean, especially if plants are set on the floor where dampness can accumulate under their pots (and can soon ruin carpets or wood). Vinyl flooring is available in many patterns, and is both resilient and economical; flagstone or brick set in mortar gives an attractive "terrace" look. An especially handsome material is ceramic tile, which comes in a range of warm browns, yellows and reds. While glazed tile looks nice and shiny it can be slippery when damp; unglazed tiles have greater skid resistance.

To get still more out of a sun room, consider giving it some features of so-called "passive solar" design. Almost any glass addition will add warmth to a house when exposed to the sun, but it may lose that warmth and more, unless it can be closed off from the rest of the house on cold nights or cloudy winter days. The simplest way to avoid this is to leave the old exterior house wall intact, open existing windows and doors to bring heat from the sun room into the rest of the house when the sun is shining, and close them when the temperature of the sun room drops.

For greater efficiency, some owners install closable vents high on the old exterior wall to allow accumulated warm air to flow into the house, and more vents near the floor to allow cool air to flow from the house to the outer space, thus setting up a natural convection cycle. (A thermostatically controlled fan in an upper vent can speed the process; if it is reversible, it can also be used to force warm air into the sun room to keep the temperature up on cool nights.)

Much the same effect can be obtained by replacing smaller doors and windows in the old wall with tall sliding-glass doors. When these doors are slid back by day, warm air flows into the house through the upper part of the opening, and cool air flows out from the house into the sun room along the floor. When the doors are closed at night, their double glazing provides insulation from the lower temperatures of the outer space, which can be allowed to go as low as 45 degrees or 50 degrees Fahrenheit without harm to most plants (many species, indeed, prefer cooler conditions at night). As a bonus, sliding doors can also brighten dark living areas and make the sun room a more visible, and appealing, part of the house.

To store sun heat by day, and slowly release it at night to keep temperatures from going too low, a sun room should have some materials with "thermal mass." The most common is masonry, in the form of a floor of ceramic tile or brick laid on a concrete slab, or interior walls of brick, concrete block or stone.

For more specific advice on adapting such a room to your particular situation and requirements, consult architects and greenhouse manufacturers who specialize in solar design.

The author's conservatory has a glass roof supported by a cast metal framework. The stone walls match the house.

THE CONSERVATORY

J. LIDDON PENNOCK

Mr. Webster defines "conservatory" as a dwelling-attached glass house for growing plants, especially ornamental cultivated plants. He infers, and correctly so, that this type of structure is created to be a showcase for decorative plants rather than a growing greenhouse.

A conservatory should not be equipped with benches which are necessary to bring plants from the seedling or rooted cutting stage to total fruition. Instead, it should feature display areas to give the impression of planted beds. A conservatory is designed to have the feel-

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ing of an outdoor garden transported inside.

Although it may seem like a simple feat, it is not easy to preserve the illusion of floral bounty and, at the same time, heat a decorative plant room. The obvious place for radiation units would be in front of, or directly under the windows. This area, of course, is also the ideal location for the massing of plants. Radiant heat under the floor surface is another possible solution that proves unsuitable because specimen plants placed directly on the floor are important to the appearance of the design and yet they suffer just as any plant would suffer if placed on a warm stove.

The best location for heating units is directly under the entry or exit doors where plants would obviously never be located. Oil-fueled units are the most cost-effective system for heating a conservatory. They can be housed under the floor surface and covered with a heavy grill the length of the door openings. These units come equipped with remarkably silent fans that will efficiently circulate air throughout the room, thus insuring an even temperature at both the ceiling and the floor level. The temperature can be regulated by a thermostat to control the variation in temperature, day or night. Hot water is piped to each unit and connected directly to the hot water system emanating from the same furnaces that heat the residence.

In Meadowbrook Farm's glass room conservatory, the high roof ceiling of the room is composed of one-half-inch-thick plate glass, supported by a cast metal structural framework which rests on stone walls that match the house itself. As an alternative, an A-line roof could have been used, consisting of a strong center joist and supporting rafters about 18 inches apart with glazed thermo-pane and a double walled clear plastic material called Lexan or Polygal (a General Electric product). The interior surfaces are simply cement stucco, mixed without lime due to the high moisture content of the atmosphere.

The walls give the structure the look of a glass room rather than a working greenhouse. The room also has openings in the walls equipped with sliding panels and screening. The heating units are located under these two doorways.

Indirect lighting fixtures were installed in the ceilings of each of the recessed doors and windows. The valences are simulated carved wood panels created out of white styrofoam and molded to look like antique paneling. They conceal the sources of all the interior lighting. Additional illumination through the glass roof is supplied by 150 watt flood lights affixed outdoors to the upper eaves above the glass room, contributing considerable drama to the night lighting effect.

Ficus pumila, the climbing fig, was used to conceal the metal rafters. At the base of each narrow wall area there is a 12 by 14-inch excavation cut through the marble floor into the base soil. Small ficus plants were then inserted in the exterior walls of the residence. As the vine grew up the interior wall, one leader was encouraged while most laterals were removed. The vines finally reached the rafters and commenced to cover the metal framework eventually developing into hanging swags and other forms. These have now taken the place of many hanging baskets which were used to grace the originally bare looking structural ceiling.

The eight narrow trenches containing the ficus are the only permanent planting beds. All other plants are displayed in movable galvanized metal trays matching the width and length of all the glass wall areas, except the doorways. This enables the pattern of the plant placement areas to be changed depending on

the season and the quantities of plant material available. The trays are filled with pebbles to the depth of several inches, so that if there is an overflow of water, the pots will rest above the water level. This is an important drainage factor that prevents the plants from having wet feet and thus root rot. The dampness in the pots and trays provide sufficient moisture throughout the room.

Suitable furniture is of prime importance. Furniture made of wood, aluminum, iron or wicker with upholstery that can withstand the moisture of the room is suitable. Sculpture or other ornamental features adds to the decorative effect.

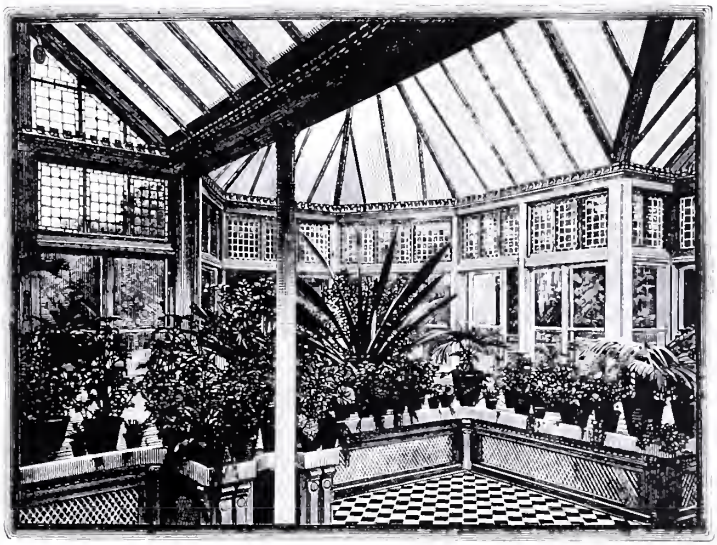
In summer, the conservatory is shaded by trees—pines and *Magnolia grandiflora*, planted on the west and south sides of the structure. If deciduous trees were used they would produce shade when in leaf and good light when the leaves have fallen. If tree plantings are not feasible, provide shade with the adjustable slat screens, saran netting, or a whitewash compound to coat the conservatory roof.

The maintenance of a conservatory could be compared to that involved in any flower garden, where, to maintain perfection, a back-up area of plants is grown and dug to fill in the gaps that occur during the season. Ideally, a small working greenhouse provides the replacement material.

If orchids are part of the scenery, remove them when they are not in flower. The blooms have an exceedingly long life-span which make orchids an absolute must for this type of setting. Despite their aura of glamour, orchid plants are relatively simple to grow.

Seasonal plants such as forced azaleas and chrysanthemums can be used in a conservatory. But they must be removed when not in flower. Flowering plants that bloom over a prolonged period should be incorporated wherever possible. Foliage plants are an equally important element because they provide a leafy background.

Most importantly,creating and maintaining a conservatory is an extremely rewarding horticultural and aesthetic experience.



White wicker furniture and white latticework are interesting textural elements in this garden room filled with flowering plants.

GUIDELINES FOR BUILDING A GREENHOUSE

LINDA YANG

In 1987 more than 10,000 hobbyists' greenhouses were built in the U. S., according to Dr. Harold E. Gray, the executive director of the National Greenhouse Manufacturers' Association. The average cost of an 8-by-15-foot structure was $2,000 to $3,000; to make it a working greenhouse that figure must be multiplied two and a half times. "Less than a second car," Dr. Gray commented.

There are more than 100 greenhouse manufacturers nationwide, offering a wide variety of styles. The association has prepared a list of them, as well as guidelines on lighting, ventilation, siting and other considerations. These are available free from the association. Send a self-addressed, stamped envelope to P.O. Box 567, Pana, IL 62557.

A magazine, *Greenhouses for Living*, is devoted to the subject, with articles on questions like how to select a builder, and how to finance it. Issues cost $6.95 in bookstores and $8.00, postpaid, from 350 Fifth Avenue, Suite 6124, New York, NY 10001.

Every city has special code requirements concerning greenhouses. In New York, building permits are required, and people living in cooperatives must have permission from the building's board. Laminated safety glass or wire glass that will not shatter is mandatory. An architect or engineer is usually consulted for roof-top construction because of code requirements regarding snow load and wind shear.

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Check your local building codes before starting plans for your greenhouse.

SOLAR GREENHOUSES

COLLEEN ARMSTRONG

Generally speaking, all greenhouses are solar greenhouses because heat from the sunlight is trapped in the glazed structure. While energy-efficient solar greenhouses maximize the amount of solar gain (the primary source for heat) and minimize heat loss during the heating season, an equal emphasis is placed on climate control. These greenhouses can vary from being 100% passive solar without back-up heat, or a combination of solar and supplemental heat.

When planning a solar greenhouse, select a design that suits your needs. There are many designs for solar greenhouses. Some people build solar structures to function as a solarium or a space heater for the home. You can choose between a custom greenhouse or a kit (see table—Solar Greenhouse Kits). Custom greenhouses tend to be more expensive buildings because they are designed to blend with the existing house. One advantage to kit greenhouses is the opportunity to visit a model or an owner in your area. Ask the greenhouse owners what is satisfactory and less than satisfactory about the kit. A financial plan is equally important; solar greenhouses are more expensive than the conventional types. Solar heat is not necessarily free! A low cost, do-it-yourself solar greenhouse starts at $15 per square foot; an aesthetically pleasing, quality greenhouse averages at $100 per square foot. Also, check with your local building inspector for the code laws in your town. It may save costly delays in the future.

Site considerations depend upon your choice of greenhouse—freestanding or attached. Locate freestanding greenhouses where there is plenty of light and few obstructions from trees or other buildings. There may be a warm pocket on your property where the greenhouse could be nestled away from northern winds. In cold climates, freestanding greenhouses require more thermal mass for heat storage than do attached greenhouses.

Attached solar greenhouses are usually built onto the southern side of a house where at least six hours of sunlight reaches the area. These greenhouses have the advantage of exhausting excess heat into the house, and receiving heat from the house at night. Also, the common wall between house and greenhouse protects it from harsh, cold winds. At the same time, it restricts light from entering the northern section of the greenhouse and consequently, attached greenhouses are less productive than freestanding solar greenhouses.

A site survey to determine the most suitable location for an attached solar greenhouse should include the best possible southern orientation, the least shading by trees or other obstructions,

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designated lot lines and prevailing winter winds. True south is different from "south" on the compass; solar greenhouse textbooks discuss the adjustments needed for your area. A greenhouse facing true south gains the most light from the winter sun. If this direction isn't possible, locate the greenhouse 20 to 30 degrees east or west of south. Spend some time in the winter months plotting the sun's path over your desired location. Sketch out where the shadows lie and note the angle of the sun. Within range of due south, the winter sunlight should be perpendicular to the tilted glazing. Reference books will give you the sun path chart for your latitude (see Further Reading). Equally important, you want to plot the altitude and azimuth angles of any obstructions to the sun.

Other site considerations should include the average weather patterns for your area. Predominantly cloudy days in the winter season will dramatically reduce solar radiation when it is most needed. Note if your desired location has any peculiar microclimate qualities such as wind protection or fog. Evaluate the terrain for your greenhouse site; check for proper drainage. All of this information will aid you in deciding whether your site is suitable for a solar design.

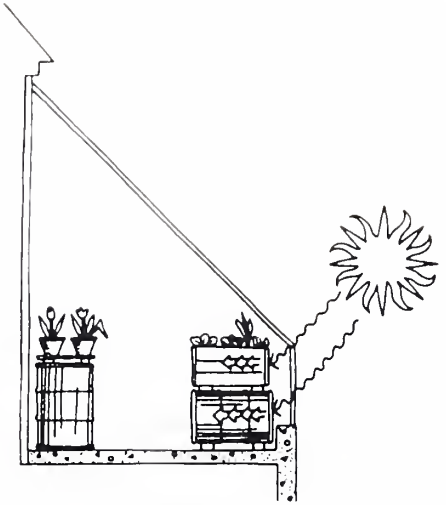


Figure 1. Heat storage and planting beds placed behind the glazing will be heated by the sun. The warm root zone will boost winter plant growth.

Not all greenhouses can operate on solar energy alone. The slope of the glazing should maximize the amount of solar

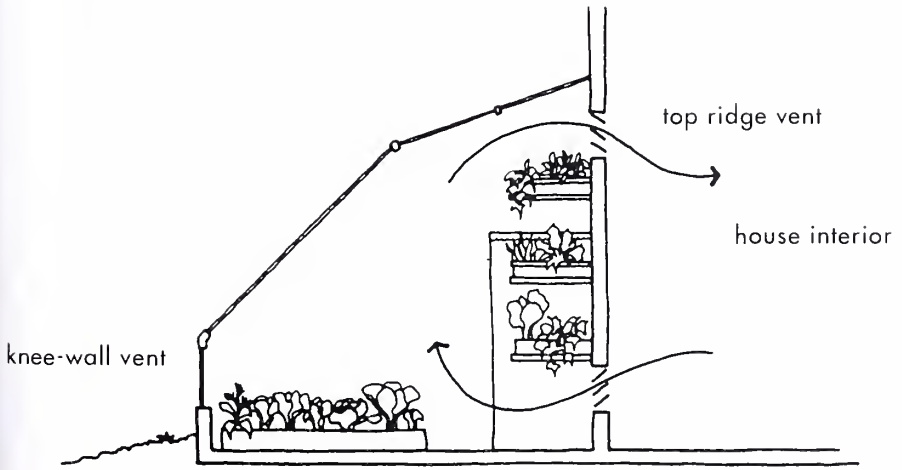


Figure 2. Daytime air circulation in an attached greenhouse.

radiation in the winter months. To determine the slope of the southern roof glazing for your area, simply add 10 to 20 degrees to your latitude or refer to radiation tables for the best glazing angle (see Further Reading). In order to enhance solar radiation passing into the greenhouse, consider glazing the end walls and selecting framing materials which will minimize shading. Light is important for both passive solar heating and photosynthesis. Even though a larger glazed area has more heat loss, sufficient heat storage can justify it. Your choice of glazing materials and their longevity will also affect the light transmission into the greenhouse. Reflected light can also be a source of solar energy. White paint on the interior northern wall can reflect the incoming light back onto the growing area. Materials surrounding the greenhouse, such as snow, white sand or gravel can reflect light.

During the heating season, reducing heat loss is important. Heat loss can occur by radiation, conduction or convection. In a greenhouse, most of the heat is lost from conduction through the roof, walls and air leakage out of cracks and crevices. Double glazing can effectively reduce heat loss without sacrificing light quality. The air pocket in between the two glazings limits heat loss through conduction and convection. Insulating the foundation and north wall buffers the building from cold winds and frozen soils. Caulking around overlapping pieces of glazing reduces air leakage. Movable insulation which covers the glazed roof or growing area acts as a thermal blanket. Several kit greenhouses offer accessories such as thermal curtains or shades. The Chinese use rice mats to cover their earthen bermed greenhouses. Other materials such as rigid foam insulation, reflective films and fabrics, and bubble plastics are suitable for night insulation. Thermal curtains or panels can be designed to cover the outer or inner glazing surfaces.

Solar greenhouses reduce the outflow of heat by storing it in some type of thermal mass. Heat is stored most efficiently in water, and to a lesser degree in mud, masonry, rock and earth. Water can be stored in one-gallon containers stacked on top of one another, fifty-five gallon drums, tanks constructed from plastic reinforced with fiberglass or various sized containers. A general rule of thumb for cold climates: for every square foot of glazed area, one-half a cubic foot of water is recommended for heat storage. Usually water tanks are placed against the north wall where the water can absorb the heat during the day and radi-

FIGURE 3. Sucessional Planting Scheme for Vegetables in Solar Greenhouses.

WINTER	SPRING	SUMMER	FALL
Cauliflower			
SOW	HARVEST		
Tomato			
SOW		HARVEST	
	SOW		HARVEST
Lettuce			
SOW HARVEST			
SOW	HARVEST		
		SOW	HARVEST

ate heat at night. Paint the water storage containers a dark color to increase heat absorption.

In small greenhouses, water may be an impractical thermal mass. Even though masonry has less than half the heat capacity of water, it has some advantages. A concrete wall can double as both

Vegetable Varieties for Solar Greenhouses

Vegetable	Name of Variety	Light Condition
	Cool Season	
Beet	Ruby Queen	Direct
Cauliflower	Opaal	Direct
Celery	Utah 52-70 Improved	Direct
Chard, Swiss and Red	Fordhook, Rhubarb	Partial
Chinese Cabbage	Yellow Radish Bud	Direct
Endive	Full-Heart Batavian	Direct, Partial
	Green Curled	Direct, Partial
Kale	Gr. Curled Dwarf Scotch	Direct, Partial
Lettuce, loose-leaf	Green Ice	Direct
Lettuce, buttercrunch	Salina, Vasco	Direct
Lettuce, romaine	Winter Density	Direct
Pac Choi	Pac Choi	Direct, Partial
Radicchio		Direct
	Warm Season	
Cucumber	Lemon	Direct
European Cucumber	Coronna, Vetomil, Super Sandra	
Melons	Ambrosia, Charentais Improved	Direct
Peppers, Green	Ace, California Wonder	Direct
Peppers, Red	Sweet Round Red	
Peppers, Yellow		
Tomato	Sweet 100 (Cherry)	Direct
	Caruso	
	Park's VFNT greenhouse	
	Jumbo	
	Floramerica	
	Vendor	

thermal mass and structural element for both house and greenhouse and it requires less maintenance than water. Thick masonry walls (six to eight inches) tend to be more expensive than water storage systems. Deep soil growing beds absorb the heat from the sun, yet they are an inefficient thermal mass. A practical and old technique for heat storage is to build the greenhouse into a hillside and use the surrounding soil as insulation. "Pit greenhouses" are a variation on this theme; they are built into the ground and approximately two-thirds of the greenhouse is insulated by the ground. These greenhouses are limited for light but simply designed. An expensive and sophisticated alternative is to move the hot air from the top of the greenhouse into a rock storage area below the greenhouse floor. Heat from the warmed rocks is conducted into the soil beds and surrounds the plants. These systems require electrical energy for fans and ductwork.

Climate control is an essential design component. In an effort to store the daytime heat, solar greenhouses have less regulated temperature regimes than their conventional counterparts. In most 100% passive solar greenhouses, a wide diurnal temperature fluctuation occurs throughout the heating season. Daytime temperatures can rise to 70 to 80 degrees F while nighttime temperatures can drop from 50 to 40 degrees F. Some plants will not tolerate such wide fluctuations. If optimum climate conditions are necessary, then you should design for both passive solar heat and supplemental heat.

Poorly designed solar greenhouses have problems with overheating. Hot air can be ventilated from the greenhouse either passively or mechanically. Passive or natural ventilation is based on air movement by convection; warm air is exhausted out of the greenhouse while cool fresh air is drawn in. The most common natural ventilation design has windows or vents at the top of the greenhouse and low vents near the floor. The total vent area for natural ventilation should be one-sixth of the floor area with upper vents 20 to 30 percent larger than the lower vents. For windy areas, doors placed on the windward and leeward sides of the greenhouse provide adequate cross ventilation. For windless summer days, natural ventilation can be encouraged by designing for the stack effect; solar chimneys are such devices that take advantage of buoyant warm air escaping out of tall, narrow chimneylike boxes with glazing on one side. All vents should be sealed to prevent heat loss in the winter. For absent greenhouse operators, automatic ventilation is compulsory.

Mechanical ventilation is more consistent and reliable than passive methods. Usually, a wall-mounted exhaust fan combined with side vents at the opposite side of the greenhouse is sufficient. Energy-conserving solar greenhouses have ventilation rates of four to 10 air exchanges per hour. Most commercial greenhouses recommend two to four times this rate. When selecting your fan, let this general rule of thumb be your guide: fan capacity should handle 200 cubic feet per minute for every 1,000 cubic feet of greenhouse volume. Attached greenhouses should have two sets of vents; one set for exchange into the house during fall, winter and spring seasons and another for ventilating hot air to the outside throughout the summer months.

Shading the greenhouse is another technique for controlling temperature. Most glazings can be sprayed with a shading compound which is non-toxic and easily removed with soap and water. Other options are shade cloths which are available in various grades and covering the greenhouse glazing with vegetative vines such as cucumbers, melons or run-

• Passive solar heat gain & distribution • Passive summer ventilation
• Deep soil growing beds • Benches & shelves for flats & plants
• Water tubes for heat storage

nerbeans. Shading may be removed earlier than conventional greenhouse shading to access passive solar heating in the fall.

Solar greenhouses can be used for season extension or year-round gardening. In northern climates, greenhouse temperature conditions mimic two seasons, spring and summer. The greenhouse glazing acts as membrane to the outdoors and the interior temperatures are sensitive to the change of seasons. Careful plant selection can make the difference between success and failure. Many growers concentrate on vegetable production in solar greenhouses because many cool-weather crops such as lettuce, cauliflower, Oriental greens, and scal-

lions prefer springlike temperatures during the winter months. Table lists vegetable varieties best suited for solar greenhouses in northern climates. Southern growers have more flexibility with their winter selection; however, plants that respond to long day length should be avoided during short day length periods.

Many solar greenhouse growers will start their cool weather seedlings in late summer in order to have mature, ready-to-harvest vegetables before the gray days of winter begin. For a steady harvest of leafy greens, pick the outside leaves instead of cutting the entire plant. The mature plant will continue to grow and produce throughout the coldest months of the year. Parsley, coriander, dill, and chives are tasty additions to the list of winter greens. Flowering plants that prefer cool temperatures and thrive in solar greenhouses include viola, calendula, primula, alstroemeria, freesia, nasturtium, alyssum, sweet pea, snapdragons and stock. Many orchids such as cymbidium, dendrobium, odontoglossum, cypripedium and miltonia flourish in the cool, moist climate.

Solar greenhouses have an extended summer season; heat-loving vegetables and flowers can be grown for six months or longer. Early season tomatoes, European cucumbers (the long, seedless, burpless variety), peppers and eggplant can be harvested for twelve to twenty weeks. Annual flowers such as marigold, dwarf dahlia, morning glory, impatiens, begonia and salvia can be sown in early winter; soon thereafter they'll offer splashes of color.

Developing a plan for successional planting makes for steady production as well. Figure 3 is one example of an annual planting guide. As years go by, you will learn the individual characteristics of your greenhouse and you can modify the planting scheme.

Further Reading

Craft, M.A. Ed. *Winter Greens.* Renewable Energy in Canada. Firefly Books Ltd., Scarborough, Ontario, Canada, 1983.

Hirshberg, Gary and Tracy Calvan, Eds. "Solar Greenhouse Gardening," pp 49-88, *Gardening For All Seasons.* New Alchemy Institute. Brick House Pub., Andover, MA, 1983.

Mazria, Edward. *The Passive Solar Energy Book.* Rodale Press, Emmaus, PA, 1980.

Shapiro, A.M. *The Homeowner's Complete Handbook for Add-On Solar Greenhouses & Sunspaces.* Rodale Press, Emmaus, PA, 1985.

Smith, Shane. *The Bountiful Solar Greenhouse.* John Muir Pub., Santa Fe, NM, 1982.

Thomas, S.G. et al. *Solar Greenhouses and Sunspaces: Lessons Learned.* Prepared by the National Center for Appropriate Technology, for U.S. Department of Energy, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., DOE/CE/15095-8, 1984.

Table of Solar Greenhouse Kits

Aluminum Greenhouse, Inc. 14605 Lorain Ave., Cleveland, OH 44111

Charley's Greenhouse Supply, 12815 N.E. 124th St., Kirkland, WA

English Greenhouse Products Corp., 11th and Linden Sts., Camden, NJ 08102

Four Seasons Solar Products Corp., 910 Route 110, Farmingdale, NY 11735

Harvester All-Weather Greenhouses, 257 Main St., Chatham, NJ 07928

Horizons Products, Inc., 9301 E. 47th St., Kansas City, MO 64133

Lord and Burnham Division, Burnham Co., Box 255, Irvington, NY 10533

National Greenhouse Co., P.O. Box 100, 400 E. Main St., Pana, IL 62557

Northern Light Greenhouse, Gardeners Supply Co., 128 Intervale Rd., Burlington, VT 05401

J.A. Nearing Co., Inc., 9390 Davis Ave., Laurel, MD 20707

Pacific Coast Greenhouse Manufacturing Co., 8360 Industrial Ave., Cotati, CA 94928

Solar Resources, Inc., P.O. Box 1848, Taos, NM 87571

Vegetable Factory, Inc., Sunbeam Structures Division, 71 Vanderbilt Ave., New York, NY 10169

CONTROLLING THE ENVIRONMENT IN A GREENHOUSE

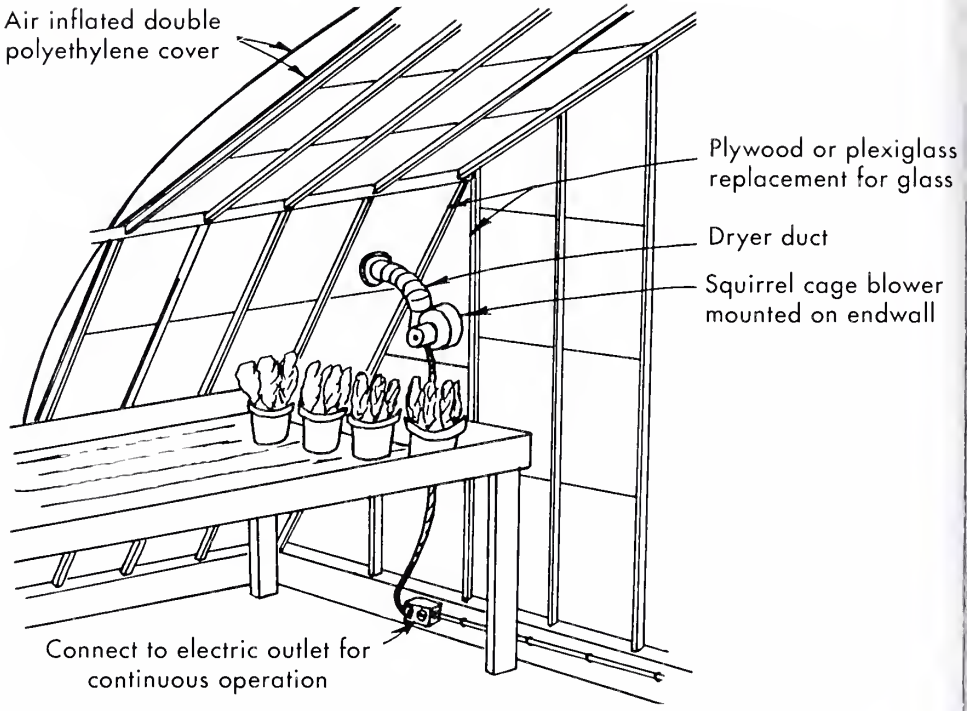
JOHN W. BARTOK, JR.

Controlling the environment within a greenhouse in both winter and summer is important to the production of quality plants. Heat, light, humidity and air quality are all crucial factors. There is a large selection of equipment available that will fit almost any greenhouse.

Heat

If the greenhouse is to be sufficiently warm to stimulate good plant growth

A profusion of plants creates a rainbow of colors in one of Logee's greenhouses in Danielson, Connecticut.


Air inflated double polyethylene cover
Plywood or plexiglass replacement for glass
Dryer duct
Squirrel cage blower mounted on endwall
Connect to electric outlet for continuous operation

Install a double-layer poly cover to cut the heating bill in half.

during the winter, a heating system is needed. If your greenhouse is attached to your home, it may be possible to connect it with the home heating system. The first step is to determine whether the system has the extra capacity needed to provide greenhouse heat. Check with a heating contractor. For hot water systems, a separate zone should be installed including a thermostat located in the greenhouse. For hot air systems, a separate control circuit and motorized damper are needed.

Where the central heating system is not large enough, or the greenhouse is free standing, an independent heater can be used. The electric heater is convenient, clean, efficient and easy to install; but electric energy is more expensive than other fuels. The heater should have a built-in thermostat and circulation fan. Also bear in mind that adequate electric supply and wiring is required.

Space heaters are commonly used to heat hobby greenhouses. Self-contained units that burn natural gas, LP gas or fuel oil and distribute the air with a blower are best. A separate thermostat located at plant level gives good temperature control. Some of the products of combustion are toxic to both humans and plants, therefore fuel-burning heaters must always be vented to the outside. Non-vented heaters should never be used in a greenhouse. With all heating systems, even distribution of heat and good temperature control are necessary to achieve uniform plant growth.

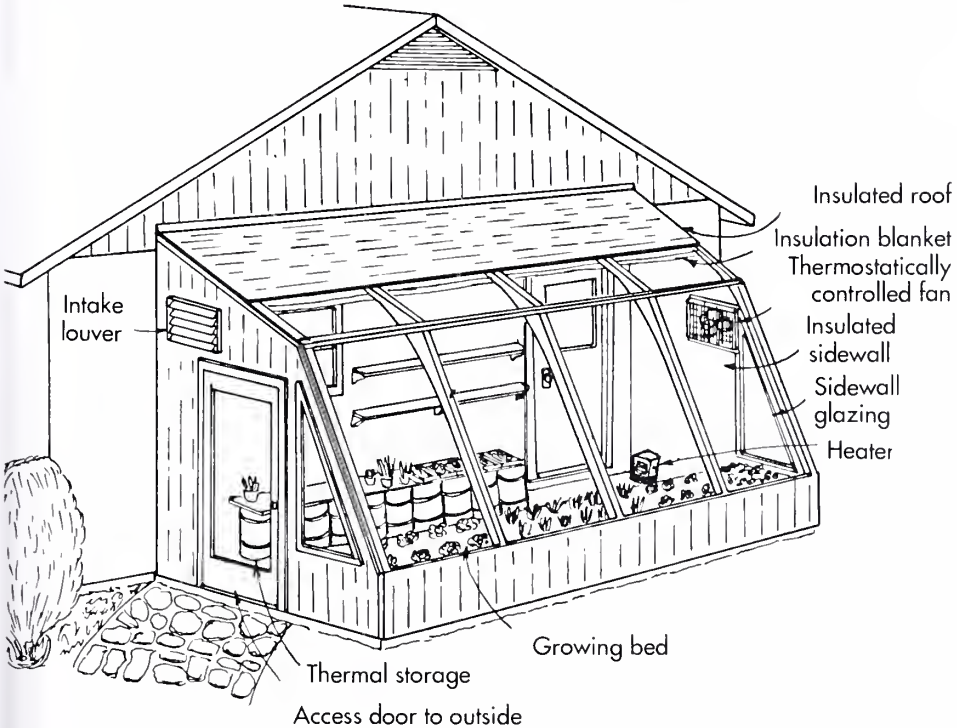
The amount of heat required depends on the temperature difference between inside and outside, the amount of greenhouse surface area and glazing, as well as the tightness of the construction. As a rule of thumb, for a free-standing green-

house located in a northern climate with 100 sq. ft. floor area, it will take 25,000 Btu/hr heat capacity to maintain 60 degrees F inside on a night when it is 0 degrees F outside. If the greenhouse has double glazing, this can be reduced by one third. For an attached greenhouse or a greenhouse located in a southern climate, only 12,000 Btu/hr will be required.

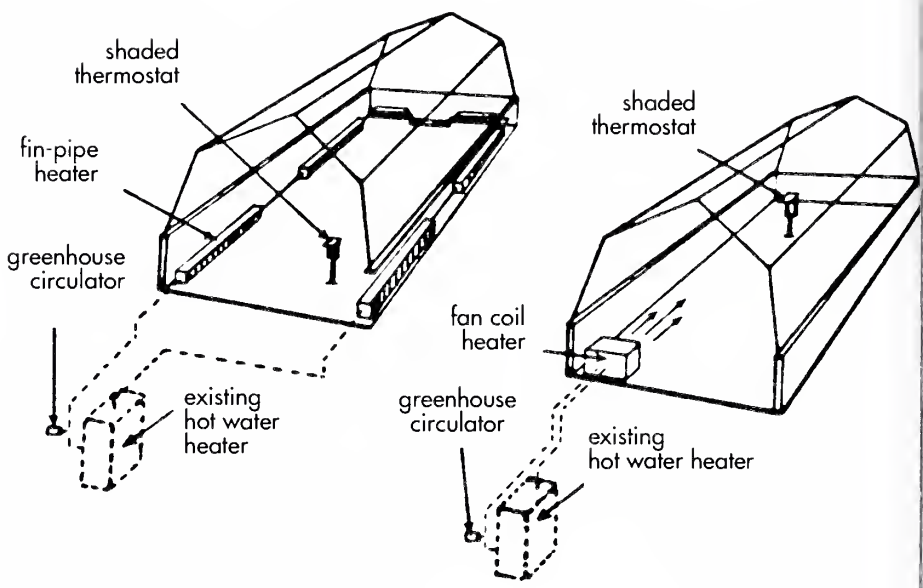
There are several methods for reducing heat loss and thereby decreasing heating costs. One of the simplest and most effective is to line the inside of the greenhouse with plastic film over the winter months. Clear polyethylene, six mil. thick is easily installed and can be reused for several years. It is available from greenhouse suppliers and lumber yards. One disadvantage is that it will reduce the amount of light inside the greenhouse by 10 to 15 percent. In addition, if your greenhouse is equipped with ridge vents, it is difficult to find a method for opening the plastic to let heat escape on sunny winter days.

If your greenhouse has a lot of hanging baskets or obstructions overhead, it may not be practical to use the inside liner. Instead, many growers place a double-inflated poly cover over their greenhouses for the winter. The two layers are separated by the slight air pressure from a squirrel cage blower, about the size used in a hair dryer. The blower operates continuously to keep the two layers separated.

The double-inflated poly cover is easily installed. Two sheets of greenhouse-grade plastic, large enough to cover the roof and sidewalls, are needed. The plastic can be attached by



Attached solar greenhouse for growing plants



using either wood furring strips or one of the aluminum extrusions available from greenhouse suppliers. The following procedures may be used:

- Wash the outside glass to ensure better light transmission.
- Cover or remove all sharp edges that could puncture the plastic. Duct tape and foam padding work well.
- Attach the plastic securing devices to the foundation wall and sidewalls. If vents are to remain operational, attach the securing devices just below the vent. Use through bolts or long screws.
- Remove a section of glass where the duct connection will be made to the inner layer of plastic.
- Select a calm day to install the plastic.
- Fasten the plastic film with the securing devices. Pull the plastic taut but don't worry about minor wrinkles, they will disappear after inflation.
- Sidewalls can also be covered using the same procedure.
- The blower should have an output of less than 100-cubic-feet per minute and a cut-off pressure of less than 0.5-inch static pressure. These are available from greenhouse or electrical supply houses.
- Mount the blower in a location convenient to where the duct will be connected to the plastic. Flexible vacuum hose or dryer duct works well for the connection.
- Once the connection is made, the blower may be plugged into an electrical outlet and inflation started. A metal plate over the intake of the blower is used to adjust the pressure until it feels as taut as a medium-hard balloon.
- The blower should operate continuously. It will use from five to ten cents worth of electricity a day.

This method may also be used on a polyethylene-covered, wood-frame greenhouse.

Several materials are available that can be used to insulate the glass sidewalls of a greenhouse. Aircap, the polyethylene bubble material found in package cushioning, may be purchased from

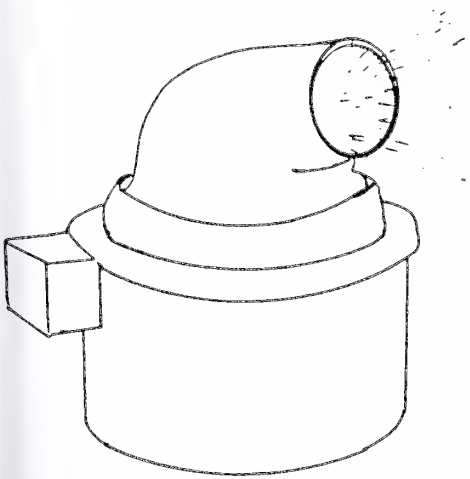
greenhouse suppliers. It can be attached by stapling or taping. However, insulation board is a better choice for areas where transparency is not important such as foundation walls, north walls and below benches. It is available from most lumber yards; a one or two inch thickness should be used.

When building a new greenhouse, it is wise to insulate the perimeter foundation wall to a depth of about two feet below ground level. The insulation can be placed either inside or outside.

Cooling

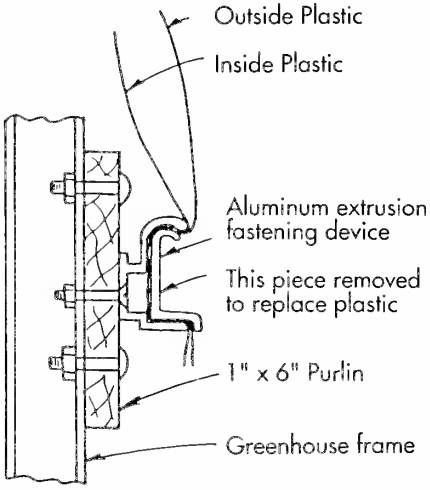
Greenhouses need ventilation for cooling, and to reduce high humidity and replenish carbon dioxide. Exhaust fans, in combination with inlet louvers, are a convenient method of ventilation because they can be automated by wiring them to a thermostat. If a two-speed fan is combined with this system, ventilation can begin at about half-rate when the outside air is very cold.

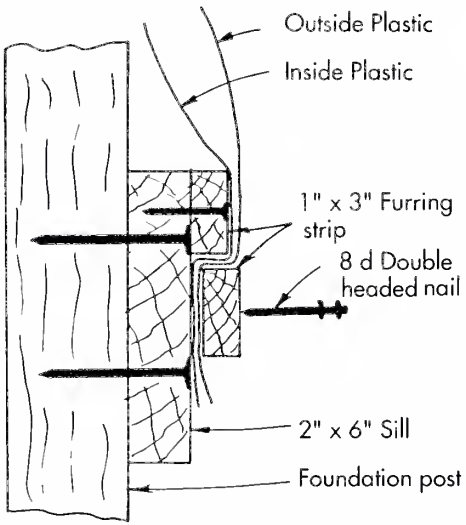
When installing the system, the exhaust fan should be placed on the end of the greenhouse, away from prevailing summer winds. A motorized inlet louver at the opposite end is then controlled by the same thermostat that starts the fan. Purchase a fan that is sized so that the capacity is at least 12 cubic-feet per-minute (cfm) per square foot of floor area. This will be adequate to remove the summer heat. To overcome resistance of the fan louvers, the cfm should be measured at O.1 inches of water pressure.



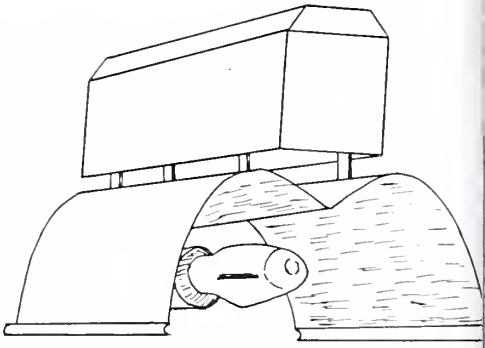
An electric humidifier will increase moisture level and cool the greenhouse.

Fastening Methods for Double Inflation Greenhouse Cover





Most glass-covered greenhouses are available with vents. A continuous vent along the ridge or top of the greenhouse provides the best natural ventilation. The ridge vent operates on the principle that warm air inside the greenhouse rises to the top of the house and escapes, while cooler air enters to take its place. Side vents can help good air flow. Automatic vent controllers that open and close the ridge vent according to temperature are extremely helpful for growers who cannot constantly monitor and tend a greenhouse.

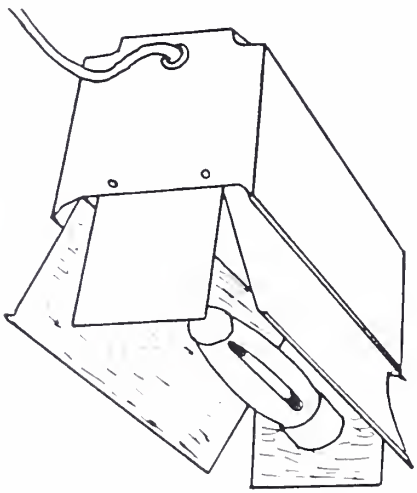


HID fixture with adjustable reflectors matches distribution with area to be lighted.

Humidity Control

Excess humidity can cause disease problems during the spring and fall months when moisture condenses on the plants. It helps to move the air with circulating fans, but a more effective means of dehumidifying a greenhouse is to replace the moist air inside with drier outside air. This is usually accomplished by cracking the vent open or turning the fan on for a few minutes.

During the hot summer days, humidity may become too low for optimal plant growth. Wetting the walks and floor area increases humidity if it is done frequently. A small humidifier can also be used.



Most HID fixtures can be adapted to either metal halide or high pressure sodium lamps.

Lighting

Light is usually the limiting factor in plant growth during the winter and on cloudy days. Two types of supplemental lighting are used.

Photoperiodic lighting for day length affects the flowering of such plants as chrysanthemums and poinsettias. Incandescent light at a very low level (less than 10 footcandles) also works well.

Supplemental lighting for photosynthesis adds to the sunlight that is needed for growth of tall foliage plants. A relatively high light level (about 500 footcandles) for several hours above the natural day length may be needed. Fluorescent lamps (usually cool white) or the newer, more efficient sodium vapor or metal halide lamps are the best choice. To control them, use a 24-hour clock timer. However, before deciding on supplemental lighting, compare the cost to the added growth of the plants. Except for high value crops such as roses, supplemental lighting has not proved to be economically worthwhile.

HORIZONTAL AIR FLOW

JAY S. KOTHS AND JOHN W. BARTOK, JR.

Plants grow better when air is continuously circulated in a greenhouse. This cools or warms the leaf surfaces and evaporates disease-promoting moisture. Also the circulation of carbon dioxide is improved, increasing growth potential. Although several systems provide air movement, the Horizontal Air Flow (HAF) method has been found to be the most effective.

The HAF concept typically uses small circulating fans operating continuously to push the air horizontally on one side of a greenhouse and back in the other direction on the other side. This creates a circular horizontal pattern. Mixing of the air occurs from the ceiling to the floor.

Other systems use different concepts. The fan-jet system uses perforated plastic tubes suspended in the peak of the greenhouse and inflated with a one-sixth to one-half horsepower fan. The lighter heated air in the upper portion of the greenhouse is forced downward through the holes in the tube and tries to displace the heavier, cooler air near the floor. The turbulence and plant canopy slow the air movement. Losses from friction in the tube and from forcing the air through the small diameter holes in the tube increase the motor horsepower needed and the energy used.

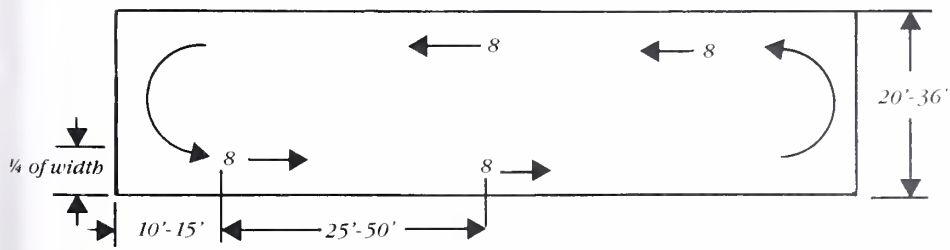
The turbulator system uses vertical shaft fans mounted above eave height to stir the air and force it toward the eaves and back across the floor, resulting in a cold spot below the fan. These fans draw air from a limited area and many fans may be needed.

Basic Air Movement Concept

When a fluid is enclosed in a container it may be moved in a coherent pattern with a minimum of energy. Fluid flow is energy efficient, being slowed more from turbulence caused by obstructions rather than by surface friction in the container.

This is an important concept in the movement of air (a fluid) in the greenhouse (a container). The air mass, once in motion, will continue to move until obstructions (plants and surface friction)

JAY. S. KOTHS, *Storrs, CT is Professor Emeritus of Floriculture at the University of Connecticut.*



Typical HAF fan placement (16" diameter) in a narrow individual greenhouse.

slow it. For efficiency, the air mass should be as large and coherent as possible.

In a small greenhouse less than 25 feet long, this may be achieved by placing a fan in a corner. It is most efficient when directed down the house and located one-fourth the distance across the house and one-fourth the length of the house. In houses between 25 and 50 feet long, a second fan is placed in a similar position in the opposite corner. In a 100-foot house, four fans are placed as shown on page 35.

The fan(s) should be placed high enough so that the air stream is directed into as large a volume of air space as possible to minimize turbulence. If the greenhouse is high enough to place the bottom of the fan at least seven feet from the floor, a blade guard is not required. The top of the fan should be at least twelve inches from the roof.

If the fan has a rated, free-air delivery capacity in cubic feet per minute, this should be about three times the square feet of ground covered by the greenhouse.

For small greenhouses, the efficiency of the fan is not very important. Most small fans have shaded pole motors. A permanent split-capacitor motor will deliver perhaps 50 percent more air per unit of electricity used, and are recommended for larger installations.

Operation

The HAF fan(s) should run continuously whenever ventilation is not required. This may be done manually. If the vents are automated or exhaust fans are used, HAF may be operated with the double-throw thermostat commonly used for controlling ventilation.

After installation, introduce some smoke to observe the air movement.

Concepts

Air is heavy. A 15' x 25' x 9' high greenhouse will contain about 300 pounds of air. Once it is moving, it will coast around and little energy is required to maintain its momentum.

Installation cost is low. Air can be moved faster with less cost than with fan-jet or turbulator systems.

Uniform temperatures exist. Moving the air at 50 to 100 feet per minute will eliminate stratification of warm air in the peak of the greenhouse. This reduces heat loss and may more than pay for the fans and their operation. It also eliminates warm and cold spots.

Plants remain drier. Air passing over the leaves reduces the humid air layer and aids the control of foliar diseases.

Carbon dioxide is used more efficiently. By "scrubbing" the leaves with air, movement of carbon dioxide into the leaf is facilitated and growth enhanced.

Plants are warmer. On cool, clear nights, radiant cooling may reduce leaf temperatures to 3 degrees F below outdoor air temperatures. Leaves in greenhouses will be cooler than the air if the roof is cold. Moving air transfers heat to the leaves and warms them to near air temperature.

Plants are cooler. On sunny days solar radiation heats the plants. This may cause burn on young leaves following a prolonged period of cloudy weather. Moving air cools the plant, sometimes by more than five degrees.

Pest control may be enhanced. If smoke bombs or wettable powder dusts are used, the moving air may improve the control of insects or mites.

The concept of HAF is rapidly being adopted by commercial greenhouse operators. It may improve the environment for plant growth in hobby greenhouses. In very small greenhouses, the air may be moved in different patterns, even vertically rather than horizontally. Experiment a bit. Your plants will be happier.

In a garden room conventional blinds can provide shade.

GREENHOUSE SHADING

HAROLD E. GRAY

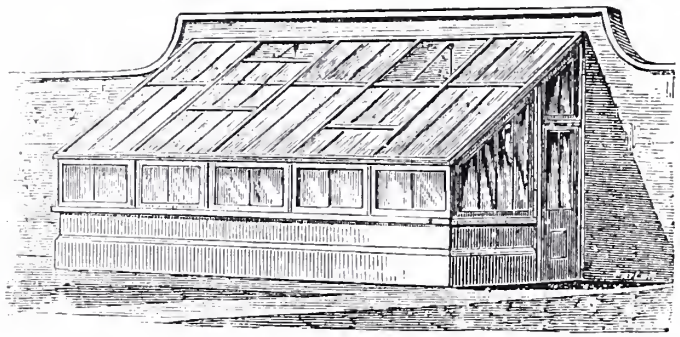
Light is essential for plant growth but too much light can be harmful. High light can cause leafburn and waterloss and reduce flower color.

Many plants benefit from partial shading. Some orchids, many gesneriads, seedlings and foliage plants grow better when the greenhouse is shaded.

Commercial growers use a shading compound — a powder or liquid that is mixed with water and sprayed or brushed on the greenhouse surface. The degree of shading is regulated by the number of coats. The compound should be washed off in the fall using detergent.

Other shading materials include evenly spaced wood slats such as snow

DR. HAROLD E. GRAY, *Pana, IL is executive director of the National Greenhouse Manufacturers Association and director of VitroTech Corp. of Champaign, IL. He is a former professor at Cornell University.*



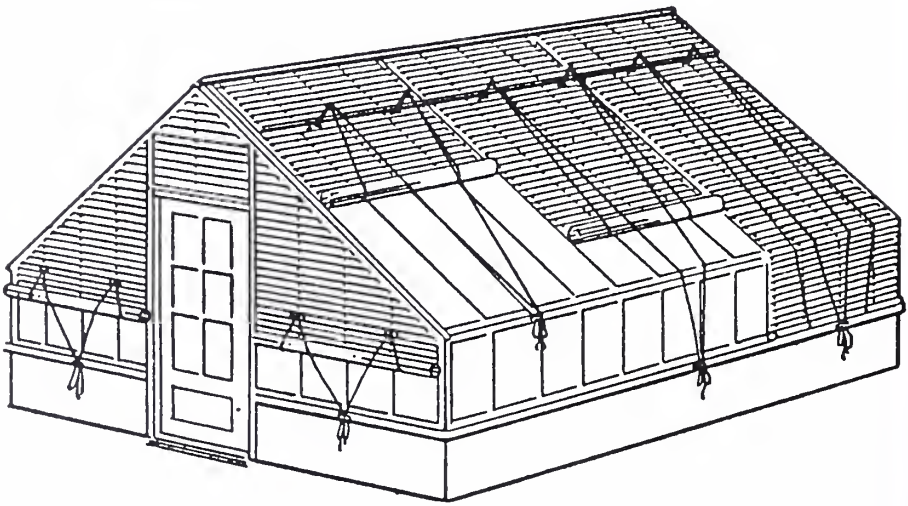
Aluminum shading attached to the outside of the greenhouse can be rolled up or down by sections to achieve different rates of shading.

fence placed on the greenhouse exterior. Roll-up shades are also an option and are available from greenhouse manufacturers. These shades can be constructed of wood or aluminum and can be placed either inside or outside the greenhouse.

Other screening materials for exterior shading are made of plastic mesh — saran and polypropylene — available in natural, green or black. The amount of shading is predetermined by the weave .

There are sophisticated systems which utilize tracks, rollers and rails built into the greenhouse frame. These systems can be operated by hand or motorized. Some materials also insulate to conserve heat and thereby reduce energy consumption.

Some trial and error may be necessary because no system is ideal for every set of conditions.



Slat shading. All of the shades can be rolled up and down the roof except those over the ventilating sash and upper part of the gable ends which are fixed with brass buttons.

LABOR SAVING EQUIPMENT

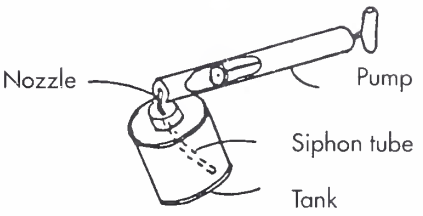
JOHN W. BARTOK, JR.

A hobby greenhouse can be operated with a few basic tools: trowel, knife, pruning shears, pails and hose.

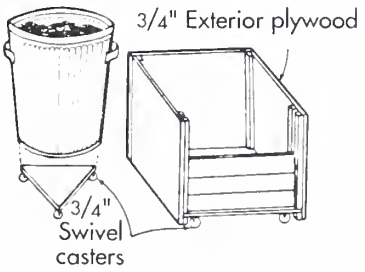
In addition to these standard items you might consider specialized labor-saving equipment. Some chores can be done better with a machine, leaving you more time for other activities. Greenhouse suppliers sell most of the equipment described below.

Preparation of Growing Media

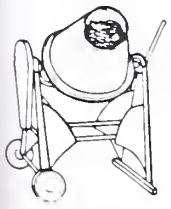
Growing media can be purchased ready-to-use or mixed in custom batches. Soil, peat, vermiculite, perlite, lime and fertilizer are the usual components of growing media. A soil shredder can be used to prepare topsoil, loosen baled peat and to mix the components. Shredders are available in capacities beginning at about four cubic yards per hour. They are powered by either an electric motor or with a gas engine. A small portable



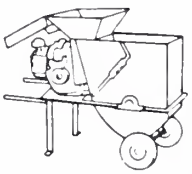
Intermittent hand sprayer



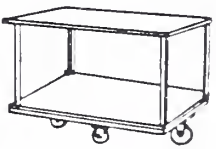
Storage bins for growing media



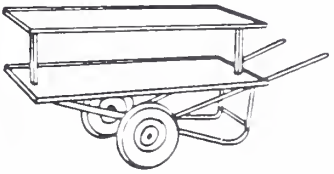
Concrete or soil mixer



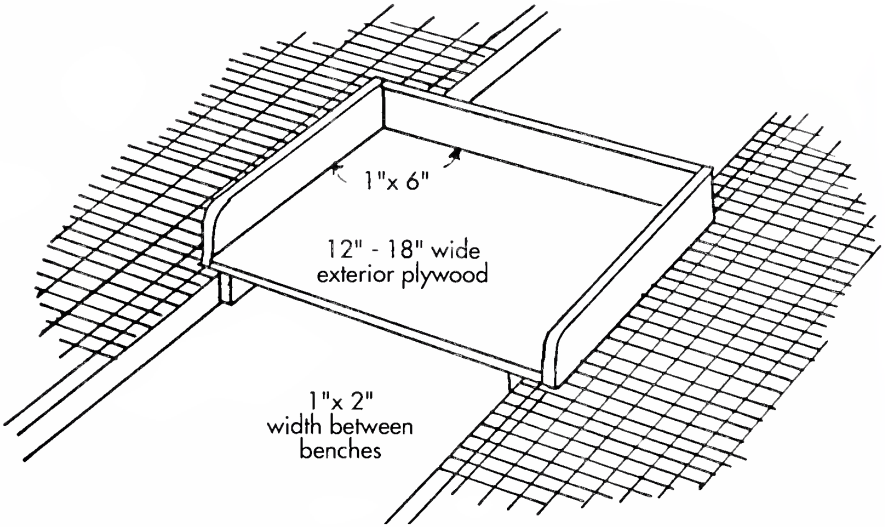
Shredder



Four wheel cart



Double wheel cart



Portable potting bench

concrete mixer is an excellent soil and peatlite mixer. A one-half horsepower electric motor or two horsepower gas engine can be used to power it. A small screen is handy for removing stones and clumps from soil and is simple to make. It can be folded and stored in the headhouse or garage.

Before it is used, soil should be pasteurized to kill disease organisms, pests, and weeds. Heating is the most common and effective method used. A temperature of 140 degrees F for two hours or 180 degrees F for 30 minutes will destroy most disease organisms and weeds. Best results are obtained if the soil or mix is loose and slightly moist at the time of pasteurization. To conserve energy, only the soil needs to be pasteurized. It can then be mixed with peat, vermiculite, perlite or other disease-free components. An electric roaster works well for pasteurizing small amounts of soil. It will do about one flat at a time. Small commercial soil pasteurizers that process one-eighth and one-fourth cubic yard per batch are available. These also operate on electricity and use from six to 12 kilowatt hours per cubic yard.

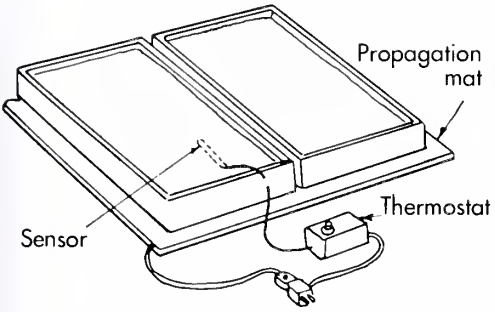
It is important that soil or mix be stored in containers or in an area where it will not be re-contaminated. The commercially prepared peat-vermiculite mixes are usually stored in their shipping containers until used.

Plant Treatment

Battery-powered and electric seeders aid in seeding. Seed is poured into the scoop and held over the bed or flat. The unit vibrates to feed the seed evenly.

Heating pads, and mats under the soil mix in the bench, provide additional heat for the propagation of cuttings and seedlings. They are available in several sizes. A built-in thermostat controls the temperature level.

The effectiveness of an insecticide or fungicide depends to a large extent on the thorough application of the material. A hand atomizer is commonly used to apply insecticides to small areas. They are available in capacities from one-half pint to two quarts. This sprayer is inexpensive so several may be purchased, one for each type of spray material used.



A propagation heat mat can provide the ideal temperature for seed germination.

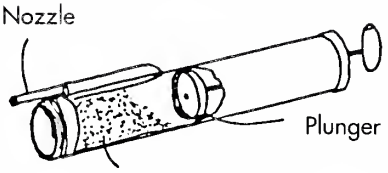
The compressed air sprayer provides better atomization and spray coverage, especially to the underside of leaves. It is available in capacities from one to five gallons. Since these sprayers are not equipped with an agitator, they must be shaken frequently when wettable powders are sprayed. The plunger-type duster is commonly used to apply pesticides in powder form.

Materials Handling

Single- and double-wheel carts are handy in the home greenhouse when materials need to be moved. Look for large wheels for easy rolling, and make sure the cart is narrow enough to go through the door.

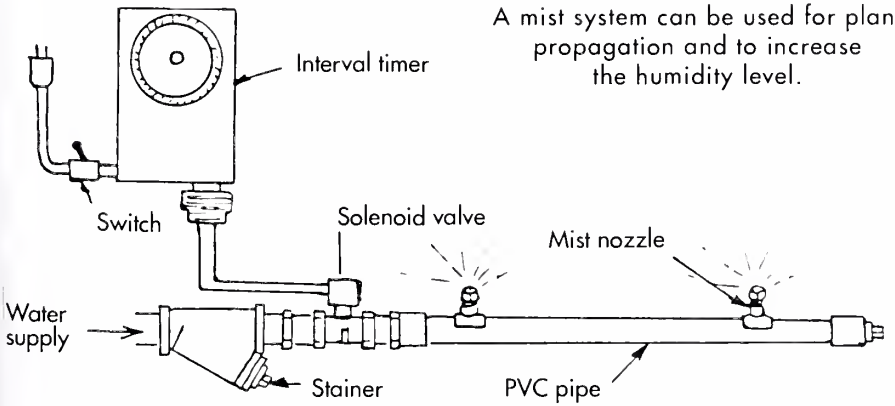
Watering and Misting

Daily hand watering with a garden hose is the most common watering system. Short hoses and several faucets are more convenient than one long hose. You should probably install more than one faucet if the greenhouse is longer than 12 feet. Water breakers attached to the hose will keep soil from being compacted or washed out of the pot or bench. Water potted plants until water begins to flow from the drainage hole. More water will only saturate the soil or reduce the amount of air in the soil; air, as well as water and fertilizer, is necessary



Plunger duster

for good plant growth. Plants should be segregated in the greenhouse according to their water needs as well as their growth cycles. Cacti should be separated from moisture-loving subtropical plants, for example.



A mist system can be used for plant propagation and to increase the humidity level.

Plants should be watered in the morning so they can dry before evening. Water droplets will cause spotting on some plants and increase fungus disease. A watering can is particularly handy for watering potted plants in a small greenhouse. The spout, with sprinkler head removed, easily reaches beneath plant leaves to water the soil.

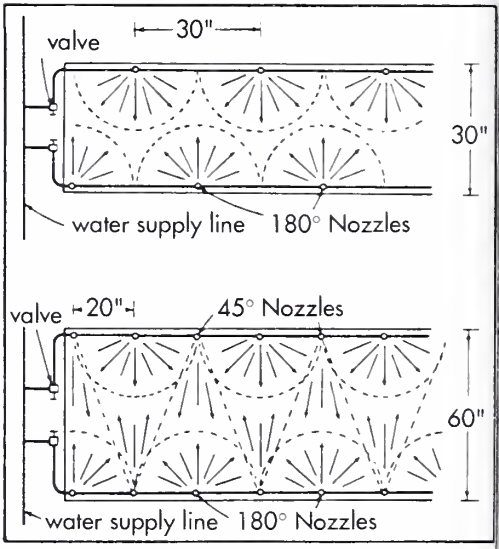
Automated watering systems are very convenient for the busy gardener. Plastic nozzles are used to water plants grown in benches. A convenient system uses a polyethylene pipe clamped, or laid along both sides of the bench. Nozzles that spray in a half circle (180 degrees) are inserted along the pipe.

The spaghetti-tube system conveniently waters potted plants. The thin tubes are inserted into a main, one half-inch diameter, polyethylene tube that runs down the center of the bench. Tubes are held in place with a lead weight, a short piece of one half-inch polyethylene tubing, or are tied to a label stake.

A time switch wired to a solenoid valve automates these systems. Some experimentation is needed to decide how long the water should run. The amount of water needed will depend on the season and light and temperature conditions.

A line strainer should be used with any automatic watering system. The strainer filters out any sand or dirt that might clog up the small holes in the nozzles or tubes.

In winter, some plants may not grow well when watered with cold water. The next day's water supply can be stored in a tank or other container so it will warm to room temperature. If you use a hose or automated system, a hot water line and mixing valve can be installed.



Layouts for plastic nozzle watering systems. Automated watering saves time for other projects.

Overhead mixing increases humidity and cools the greenhouse. High humidities are particularly important for rooting cuttings or, in some cases, germinating seed. Misting nozzles, controlled with a time switch, produce a fine spray to keep humidity high. Nozzles are normally mounted 24 to 30 inches above the bench and spaced four feet apart. Water pressure of 30 to 60 pounds per square inch is required for proper operation. Usually the nozzles are timed to operate at a ratio of one on to 60 off, such as six seconds on and six minutes off. Air movement, temperature, and water pressure will modify this ratio. The timer controls a solenoid valve and a day-night timer or manual switch turns off the system at night. A line strainer is essential to avoid plugging the nozzles.

Capillary mat watering

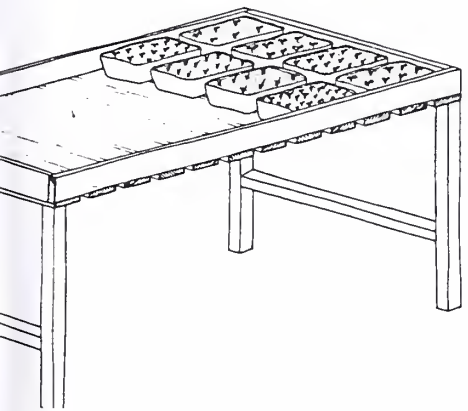
GREENHOUSE BENCHES

MIRANDA SMITH

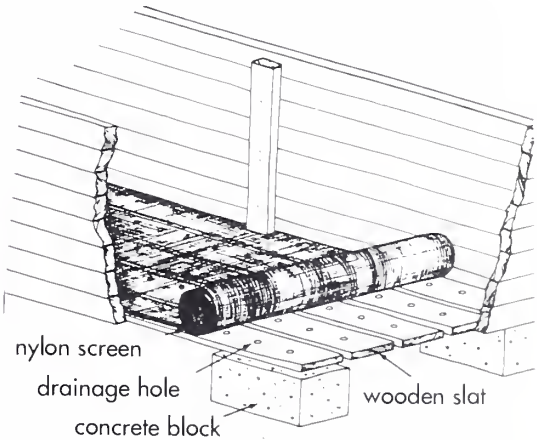
Benches are most useful in greenhouses or areas devoted to seedling or potted ornamental production. The traditional bench design looks like a long, slatted-board table with a one- or three-inch lip. Slats allow excess water to drain. Nonetheless, protect wooden benches with a preservative (see "Tips for Long-Lasting Wooden Structures").

I prefer to make benches from wooden two by four frames covered with bench mesh, a strong metal screening available from greenhouse suppliers. It is wonderful material: strong, lightweight, easy to sterilize and non-shading. Good wire cutters or a welding torch are the only tools that will cut it. You will need U-shaped nails to attach the mesh to the frames. Turn the benches so that project-

MIRANDA SMITH, *North Troy, VT, has been growing and working in greenhouses since she was a child. She is the author of* ***Greenhouse Gardening*** *published by Rodale Press.*



SLATTED BENCH:
This greenhouse workhorse is a great place to locate seedlings and potted ornamentals.
The slats allow water to drain away.



DEEP GROWING BED:
You must provide plants with good drainage and air circulation. In this bed the open-spaced slats, drainage holes and concrete blocks ensure that water will escape and air will circulate.

ing two-by-fours form a lip. If you plan to use heavy pots on a wire bench, add cross-supports at three-foot intervals.

The most stable and versatile legs for benches are wooden two by four sawhorses. But almost anything else will work as well. Some people use a couple of plastic or wooden crates while others pile up cinder blocks. Height is determined by convenience; benches aren't solid enough to interfere with air circulation. I like to work with benches about three feet off the ground. At this height the root zone is quite warm, and besides, my back doesn't hurt after a long day of potting or transplanting.

Almost every greenhouse can use at least one bench. Many herbs and ornamentals grow in small pots as well as, or better than, they do in a bed. Benches also make very good starting areas for seedling flats because it is so easy to transform them into propagating chambers. The space under a bench is a handy storage area. Fill it with boxes of pots, buckets of soil mix ingredients, and jugs of liquid seaweed and fish emulsion. In the fall it is easy to clear all of the pots off the bench and use it for drying rack for onions or a curing area for a winter squash. Draped with a sheet of polyethylene, benches make good vegetable and herb drying areas.

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The benches at Longwood Gardens are made of metal with a mesh cover to assist in drainage.

A greenhouse made of wood is attractive and will last if protective measures are taken.

TIPS FOR LONG-LASTING WOODEN STRUCTURES

MIRANDA SMITH

Naturally durable woods such as cedar and cypress, or lumber treated to resist decay, can prolong the life of wooden structures. Pressure-treated lumber is often used in greenhouses. Since it has been treated with arsenic compounds, the safest way to use it is as part of the structural frame. Don't use it for containers that will come in contact with the soil. Cedar and cypress, which naturally resist decay, are the best choices for growing

beds. These woods can be expensive, but perhaps you can locate other growers in the area who would be willing to join forces to place a large order that would qualify for a reduced rate.

If you can't locate these woods, or if they're not available, you can use a wood preservative to treat beds and containers. The safest preservative is copper naphthenate (sold under the trade name Cuprinol). It is very effective, and while it poses no harm to plants or people, copper naphthenate does kill soil fungi and bacteria for a brief period of time after application. It also releases volatile toxic solvents as it dries. When you use copper naphthenate on lumber for beds, let the boards weather outside for a few weeks before exposing them to soil.

Try not to use paints or preservatives inside the greenhouse when plants are growing there. If you must do so, wait until a week when the weather is warm enough to leave the greenhouse open all night. Vent as completely as possible during the entire time that the paint or preservative is drying...and then add a few days for extra measure.

While I'm insistent upon treating all wooden parts of a greenhouse structure with preservatives, I use beds made of untreated wood, lined with plastic film. These beds might rot a few years before preserved wood will, but they pose no threat to soil life. I use six-mil construction-grade polyethylene stapled to the sides of the beds or to any wooden containers. I never use it to cover the bottoms because that would prevent water from draining away. ❦

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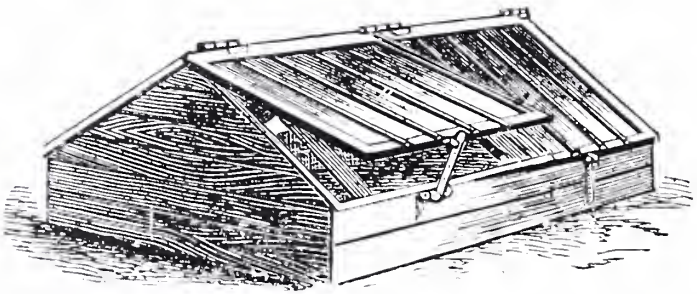

WATERING A GREENHOUSE

TOVAH MARTIN

There is no melody as sweet as the gentle tinkling of water as it passes from hose to pot. Without a doubt, the sound of water splashing over one thirsty plant and another is music to any grower's ear. A well-watered greenhouse is heaven on earth, whereas a poorly watered house can be hellish.

Watering is the greatest chore in the greenhouse, and also the most relentless job that a grower must perform. Day after day, week after week, month after month, a greenhouse must be watered. Even on the darkest, cloudiest day there is always a dry pot here or there. In mid-winter, the plants can wait until tomorrow. In mid-summer, their thirst can scarcely go unquenched another hour.

Although watering is definitely a chore, it is much less arduous in modern greenhouses than it was a century ago, thanks to 20th century technology. Until this century, water was collected in cisterns from roof gutters along the outside greenhouse frame. The system worked marvelously during rainy seasons. But, in times of drought, it did not function as effectively. When the cisterns failed, growers resorted to hauling water from nearby ponds. On a hot, dry day, as soon as they had completed one round of hauling and watering, it was time to start at the beginning and rewater the entire house.

Fortunately we now have running, piped-in water available, and every greenhouse should be equipped with water pipes. However, even with an endless supply of water at your beck and call, watering is still the ruin of many greenhouse collections. Watering may seem like a simple procedure, but every year hundreds of plants perish due to faulty watering.

No one can tell you exactly how to water a greenhouse—it is a skill that must be learned through trial and error. Anyone who waters according to a strict schedule is doomed to failure—Mother Nature simply does not go by the clock. During a rainy week your plants may only require watering twice. But on a bright, sunny week your greenhouse will probably need watering both morning and afternoon every day. Even these examples are not as simple as they seem. On a cold, rainy day the heating system might dry out plants to the point of wilting if watering is neglected. Similarly, in the summer, a cooling system might prevent the plants from drying out. Vigilance is the only truly effective method of scheduling weekly watering.

Basically, you should water when a plant is dry to the touch. Experienced growers can tell a dry plant at a glance. For those who are new at the job, feel the soil by digging a finger down about one-half inch and test it for moisture. When

When watering, allow the hose to run in a gentle stream.

it is dry to the touch, give the plant a drink.

When watering, allow the hose to run with a gentle stream into the pot, directing the water with your finger, or you might try adding a wand or sprinkling attachment to your nozzle. If the water splashes out of the pot or loosens soil on the surface, it is running too strongly.

When giving a plant its drink, fill the pot to the rim with water. Every plant should have a one-fourth to one inch (depending upon the size of the pot) lip without soil, left specifically for holding water. Only fill the lip once, do not allow it to soak in and then, fill it again. And always water in the morning so that moisture on the leaves will dry before sundown.

One of the cardinal sins in greenhouse growing is overwatering. Everyone has done it once in a while — especially with their favorite plants. It is difficult not to kill a plant with kindness. But, it is far better to underwater than to overwater. When you overwater, you saturate the air pockets around the roots with moisture, leaving the roots suffocating for oxygen. The plant can fall prey to a host of ills including root rot and other related maladies. In fact, a slight wilt stimulates bud formation in many tropical plants. When it comes to watering, most plants thrive on neglect.

In general, you will find that plants in clay pots require more frequent watering than those in plastic containers. Hanging pots usually require twice as much water as plants set on the ground. And plants that are pot-bound and need repotting cry for water continually and wilt pathetically between drinks.

Certain plants require individual care when watering. Gesneriads (members of the African Violet family) prefer warm water. You might give them their drink early in the morning if your water pipes are warmed by heating pipes. Gesneriads also object to wet foliage, so take care to water the soil and not their leaves.

In addition to water, the hose can also dispense fertilizer at the same time, thus accomplishing two chores at one time. Many growers prefer to fertilize with dilute solutions (usually one teaspoon to one gallon of water) every time they water. If this method is followed, the precaution should be taken to flush residues from the plants every fifth watering with clear water. Hose attachments that fit into the spigot are available, running a slender take-up tube into a bucket filled with partially diluted fertilizer. Not only are you providing your plants with refreshment, you are also nourishing them.

Proper greenhouse watering is rarely mastered overnight. However, once you have learned the ropes, it comes naturally. Although it is a chore, it can be an enjoyable job. Watering is both therapeutic and fulfilling. A tremendous sense of accomplishment accompanies a grower as he or she watches each plant gratefully drink its share and instantly perk up.

Sweet peas growing on a tripod.

GROWING VEGETABLES IN THE HOME GREENHOUSE

KAREN K. RANE

Raising vegetables to maturity in a greenhouse when conditions are unfavorable for gardening outdoors provides a considerable challenge. However, the rewards are well worth the effort. With a little knowledge, patience and experience, anyone can grow a variety of garden-fresh vegetables in a small home greenhouse long after the summer is past.

Plant Selection

In addition to your personal taste preferences, deciding which vegetable crops to grow will depend on your greenhouse environment (especially the temperature and light levels) and the space available. The vegetables that are most suitable for greenhouse production include leafy vegetables, radishes, cucumbers, peppers and tomatoes.

In many cases, certain cultivars have been developed specifically for commercial greenhouse cultivation. In addition, maximum use of limited greenhouse space can be accomplished by growing cultivars developed for containers or small gardens. These tend to have a more compact growing habit than other varieties and mature more rapidly.

Temperature and Light

Vegetables require the same light and temperature conditions regardless of

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whether they are grown outdoors in summer or in the greenhouse in winter. During the winter, light and temperature can become limiting factors in vegetable production, especially in northern latitudes. It is often difficult to predict the time to maturity of greenhouse vegetables. When planning their planting schedules, many greenhouse gardeners fail to take into account that it may take a crop twice as long to mature when it is grown indoors.

Seedlings germinate and grow rapidly under warm conditions. Heating cables, which provide bottom heat to seedling flats, reduce the germination time significantly, especially in the winter months. However, to prevent legginess, bottom heat should be eliminated as soon as the seedlings emerge.

Optimum temperatures for growing vegetables to maturity vary according to the particular crop. Cool-season crops such as lettuce, spinach and peas grow best when night temperatures range from 50 to 60 degrees F, and day temperatures range from 65 to 75 degrees F. Warm-season crops such as tomatoes, peppers and cucumbers need night temperatures of 70 to 80 degrees F. While some greenhouses may have cool and warm spots allowing for the production of crops with varying temperature requirements, it is usually more practical to choose crops according to the minimum night temperature maintained in the greenhouse.

Temperatures may also be a limiting factor during the summer months, when cooling the greenhouse becomes a problem. Excessive heat build-up can be controlled with cooling systems and shading. But many gardeners, especially those in southern areas, find it easier to close down their greenhouse during the summer.

The duration of light is also important for vegetable growth. Some crops, such as beans and peas, are stimulated to produce flowers and fruit under conditions of increasing day length. This requirement can be met by using supplemental light during winter, or growing the crop in early spring to take advantage of the naturally increasing day length.

Light quality and intensity are equally important. In general, vegetables grown for foliage can tolerate light of less intensity than vegetables grown for fruit production. Natural light intensity can be increased with supplemental lighting. However, it is less expensive to grow crops adapted to the prevailing light conditions of the season. Tomatoes, peppers and cucumbers will produce relatively good crops in spring and fall. Whereas, during the cloudy, short days of winter, greenhouse growers in northern climates will have more success with leafy vegetables. Those greenhouse gardeners who reside in southern locales generally have more flexibility with regard to vegetable production because light levels in these areas do not vary as greatly with the changing seasons.

Growing Methods

Starting vegetable plants from seed in a pathogen-free growing medium is the best way to produce plants for the greenhouse. Plants transplanted from outdoor vegetable gardens often harbor insects, weeds and disease-causing microorganisms which will continue to cause problems in the greenhouse environment and spread to other plants.

Advanced planning is necessary to have vegetable plants ready to be transplanted for greenhouse production. For example, tomato seed should be sown in late June in the Northeast for fall greenhouse production, and the spring tomato crop should be started in early January.

Ground beds

Vegetables can be planted in the soil on

which the greenhouse stands if organic matter and other amendments are added to the existing soil. This method allows tall crops grown on strings or trellises to attain their maximum height. In addition, root room is also maximized.

Optimally, the soil should be pasteurized to reduce root-rotting microorganisms. Steam lines can be built into the ground bed to allow the soil to be periodically steam-pasteurized, but this is not always practical.

Bag culture

An alternative to a ground bed is relatively recent practice of growing vegetable crops directly in bags of soilless media placed on the greenhouse floor. Plants are inserted in holes cut in the top surface of the bag, and drainage holes are cut in the bottom surface. The problem of soil pasteurization is avoided (commercial soilless mixes are free of root pests) while the use of maximum greenhouse height is maintained. A three-cubic-foot bag of peatlite mix can accommodate two large tomato plants. The bags are discarded after use to avoid root rot problems.

Containers

Containerized vegetable production is probably most adaptable to the home greenhouse, especially if the greenhouse has some sort of bench structure. There is an unlimited array of containers suitable for growing vegetables. The containers should be large enough to provide adequate room for root growth. In general, a minimum depth of nine inches and a minimum diameter of 12 inches is necessary.

Drainage holes are essential. Containers can be constructed of clay, plastic, concrete or wood. Deep wooden boxes are especially convenient for growing root crops.

Containerized vegetables thrive in a well-drained growing medium, whether it be a soilless mix or a soil-based medium. The pH should be maintained at 6.5 to 6.8. Most importantly, all components of a growing medium should be free of pathogens. If field soil is used in a homemade mix, it should be pasteurized for 30 minutes at 180 degrees F.

Special Greenhouse Problems

In the garden, insects pollinate flowers of vegetables grown for their fruit. But this task must be performed by the gardener when vegetables are grown in a greenhouse. Tomato, pepper, bean and pea plants can be shaken to distribute pollen. A small brush, inserted into each flower, can also be used. Cucumbers and squash must be hand-pollinated with a brush, since these vegetables produce male and female flowers separately. An exception to this rule is the European cucumber cultivars which are bred specifically for greenhouse production.

High humidity in greenhouses can encourage diseases that would not ordinarily cause problems on outdoor vegetables. Certain fungus diseases such as leaf mold on tomato plants and Botrytis blight on lettuce leaves can become severe in greenhouse environments.

Greenhouse vegetables are often subject to increased handling during transplanting, staking, pruning and pollination, which can spread disease-causing agents such as tobacco mosaic virus. However, simple sanitation practices, such as removing plant debris, discarding sickly plants and washing hands often while handling corps, can reduce the spread of disease. Controlling humidity levels through ventilation and adequate plant spacing will also help to control diseases in the greenhouse.

Vegetables grown in the greenhouse are subject to the same insect pests that attack greenhouse ornamentals. Careful attention to insect control is necessary

for successful greenhouse vegetable gardening. Insecticides should be used with caution and according to the label directions, especially since the crop will be consumed.

Some Common Greenhouse Vegetable Crops: Tomatoes

There are many cultivars of this crop which perform well in the greenhouse. 'Vendor', 'Caruso', 'Jumbo' and 'Dumbo' are a few of the cultivars developed specifically for greenhouse production, but many garden cultivars also produce a good greenhouse harvest. Choose disease-resistant cultivars.

Tomatoes can be planted as a fall or spring crop, but the harvest will be much greater in the spring. Greenhouse tomatoes may take 100 to 140 days to reach maturity from seed, and need warm temperatures (60 to 65 degrees F at night to 70 to 75 degrees F during the day) for best production.

Ground beds, bag culture and large containers are all suitable for growing tomatoes; and mulches can be used to maintain constant moisture levels. Young plants should not be over-fertilized, since this encourages soft growth, although tomato plants do require higher nutrient levels when fruit begins to develop. Tomatoes should be pruned and trained to develop a single stem, and supported with stakes or trellises. Tomato flowers are self-fertile, but the plants must be shaken to distribute the pollen.

Cucumbers

Cucumbers are a warm-season crop, and require 65 degrees F nights and up to 85 degrees F days for optimal growth. Bright light is also needed for most cultivars, making this crop more productive during the long days in spring and summer in northern areas. 'Burpee Hybrid', 'Spacemaster' and 'Victory Hybrid' are garden cultivars that also grow well in the greenhouse if hand pollinated. European cultivars which need no pollination include 'Sandra', 'Super Sandra', 'Toska 70' and 'Superator'. 'Kosura' and 'Pandex' are two European cucumber cultivars developed to tolerate lower light and temperature conditions.

Cucumbers mature in 55 to 70 days from seed, and are "heavy feeders", requiring relatively high nutrient levels as their fruit develops. For maximum production, European cucumbers must be trained to grow vertically with stakes or trellises. Other cucumber cultivars can also be grown in this manner to conserve greenhouse space.

Lettuce

Lettuce is a cool-season crop, growing best when night temperatures are 50 to 55 degrees F and day temperatures do not exceed 70 degrees F. In general, looseleaf and loosehead (buttercrunch) lettuce types are best suited to greenhouse production. Cultivars that tolerate the low-light levels typical of northern winters include 'Arctic King', 'Captain', 'Diamante' and 'Grand Rapids'.

Spring conditions in the greenhouse are ideal for most lettuce cultivars. But for late spring or early summer production, choose cultivars that are heat tolerant and slow to bolt, such as 'Boston Bibb', 'Green Ice' and 'Slo-Bolt'.

Lettuce plants have shallow root systems, and can be grown successfully in relatively small containers. Lettuce should be fertilized sparingly, but it should be frequently watered to prevent its shallow root system from drying out.

Lettuce can be harvested 55 to 80 days after it is sown. In addition, the supply of this vegetable can be extended by successive plantings, or by harvesting outer leaves while leaving the plant intact.

Camellia

GROWING COOL-LOVING PLANTS IN A 19TH CENTURY GREENHOUSE

HENRIETTA LIGHT

The historic greenhouses on the Lyman Estate in Waltham, Massachusetts give the indoor gardening enthusiast an interesting sense of the past. The greenhouse complex, as old as any known to be still standing in the United States, was built by Theodore Lyman, a Boston merchant, at his summer home which was built between 1793 and 1798. The estate is preserved and the greenhouses kept in use by the Society for the Preservation of New England Antiquities (SPNEA).

The dwelling house was placed in a meadow between a small river to the south and a gentle wooded slope to the north. A wooded knoll to the east com-

HENRIETTA P. LIGHT *is the horticulturist at "The Vale," an historic 19th century greenhouse maintained by the Society for the Preservation of New England Antiquities. She is also a garden and landscape designer and a horticultural consultant.*

pletes a sense of place which made "The Vale" an appropriate name.

Between 1795 and 1800 Lyman had a 38-foot greenhouse built into the south-facing slope beyond the back of the house site. The greenhouse was heated by fuel burned in a rectangular metal fire box which fitted into the western end of a horizontal flue. This flue ran in front of a raised bed to a chimney at the eastern end. At present, this house is preserved, but it is not in use.

The next greenhouse was built about 1804 for growing citrus, pineapples, bananas and forced native fruit. It was one of many such greenhouses in the Boston area, where an aristocracy of successful merchants showed energetic and often scholarly interest in growing exotic fruit and improving native varieties. Plants were grown in the south-facing half of the house, and the back wall of the plant room divided it from storage space on the northern side which acted as a buffer against the cold. The builders did not know that 180 years later such a structure would be called "solar."

Around 1820 a greenhouse was added for camellias. In the relatively few years since the camellia had arrived in the New World in 1797, the lovely blossoms had caught the imagination of some very ambitious growers, amateur and professional. We have no evidence that Theodore Lyman was involved in growing and hybridizing, but he certainly patronized the culture of those exquisite novelties, and made possible a superb setting in which to grow them.

The camellia house was set against, or replaced, a 75-foot section of garden wall to the east of the fruit house. Eventually, 45 feet of that wall was glassed in to form a rose house. A fifth greenhouse was built in 1935 for the purpose of growing cut flowers. It extended to the north behind the rose house.

Contemporary greenhouse enthusiasts are indebted to the four generations of Lymans whose continued interest in horticulture ensured the preservation and maintenance of the greenhouses. The estate, diminished from its original 400 acres to 27.5, was given to SPNEA in 1951.

Although most of the original exotic and native fruits are gone from the greenhouses, the grapes planted in 1870 are still thriving. Roses are gone from the center house which is now used for orchids and other tropical and semi-tropical plants. As for the camellias, there are thirteen thriving trees which are more than 100 years old and have reached heights between 15 and 25 feet!

The camellias are housed in a 15 by 90 foot greenhouse. It is a lean-to-design built against a brick wall with top and side vents, manually operated, running the length of the house. The upper glass of this house (and throughout the greenhouse complex) is now insulated with a polyethylene bubble, two layers inflated by air pumped by an electric motor through plastic tubing. The camellia trees are set permanently in large, three foot-square planters formed in the front by a vertical low wall of concrete two-feet high. This parallels the back wall of the greenhouse three feet behind. The trees are set four and one-half feet apart in soil between these front and back walls. Redwood partitions form side walls.

The camellia collection is truly the showpiece of the greenhouses. 'Alba plena' starts its distinctively long blooming season in late October. The other varieties follow, each at its own time, creating a peak of bloom in February. 'Peppermint' and 'Virgin's Blush' are still blooming in April. The blossoms are pink, white or red, two and one-half to four inches in diameter and often appear on almost every growing tip of a tree.

The Lyman Estate is open to the public for a small admission charge.Visitors

who come in from New England's damp or bitter cold, from gray days of early darkness or winter rain and mud, take great delight in the winter garden created by the trees. The blossoming camellias inspire the frequent query, "Can I grow these?"

The answer lies, as with most plant culture, in understanding the growing conditions of the plant's native habitat. Camellias originate in thin woodlands in coastal China and offshore islands. They enjoy abundant rainfall, high humidity, and well-drained soil. They can withstand high summer temperatures and light frost in winter as long as there are no wide fluctuations in daily temperature. In a greenhouse, they require good light but no bright sun, 65 to 70 percent humidity, a 20 degree F day-night temperature range, ideally 60 degrees during the day and 40 degrees at night (the colder the temperature, the longer the blossoms last), well-drained soil with a pH of about 5.5, and good ventilation. Come summer, the pots should be sunk in the ground outdoors in filtered light or semishade.

If not controlled, camellias will eventually grow too large for easy handling. When their roots have filled a 12-inch pot, do not move the plant on to a larger pot, but root prune instead. This is an alarming process for the novice, but it is harmless to a plant with a good root system. Root pruning may be accomplished any time between late winter and early spring, before the air is so warm that the plant would be stressed. Cut away an inch and a half of soil from the sides of the root ball with a long, sharp knife, and cut three pie-shaped wedges from the sides of the bottom. Then put fresh soil into the old pot, positioning it to replace the wedges. Place the trimmed root ball in the pot and add fresh soil around the sides. Selectively prune the top growth of the plant in proportion to the amount taken away from the roots. Water well and keep the plant in a shady place for several days to minimize water loss. Two months after root pruning, use cottonseed meal or any all-purpose container fertilizer sparingly.

The cool greenhouse in which camellias thrive is one of the most manageable and rewarding of indoor growing environments. One of its primary virtues is the fact that there is less insect proliferation when temperatures are low. At the Lyman greenhouses, insecticides are only used as a last resort. Instead, a population of predacious spiders and wasps keep aphids, whiteflies and mealybugs at bay. Insecticidal soap is used throughout the greenhouse once a week. Watering is necessary less frequently at cool temperatures. Blossoms last longer. (Camellia blossoms may last a month!) And repotting is also less often required.

Many cool-loving plants share the camellias' affinity for low nighttime temperatures. The plants listed on the following page are grown at "The Vale" in a greenhouse that goes to 45 degrees F on many winter nights. ❦

RHODODENDRON INDICUM Once triggered into bloom by the cool nights in the greenhouse, these lushly blooming beauties will last well in the house if kept well watered.

BEGONIA X ERYTHROPHYLLA, B. ERYTHROPHYLLA 'HELIX', ***B. SCHARFFII*** Grow these on the dry side in coldest weather, to prevent rotting.

CAMELLIA JAPONICA This is the variety of the old trees at "The Vale." Buds of the showy blooms start to form in mid-summer, and open between October and May, depending on variety.

C. RETICULATA This is a species with a lankier growth habit than the above, with veined – "reticulated" – leaves. The larger blossomed plants are less vigorous and adaptable than japonicas.

C. SASANQUA This is more vigorous and fast growing than japonica, and more tolerant of cold and of bright light. Most sasanquas bloom between August and January, setting more buds than japonicas or reticulatas. The one drawback is that the delicately scented flowers shatter in a few days.

CLIVIA MINIATA Keep very cool and dry until early March, when thorough watering will trigger bloom.

CYMBIDIUM These are terrestrial orchids whose blossoms appear between November and May, lasting eight or nine weeks! Look for miniatures to save space.

JASMINUM NUDIFLORUM ***JASMINUM POLYANTHUM*** Bear yellow and pale pink flowers respectively, bare-leaved, in mid-winter. Until buds are set in fall or early winter, withhold artificial light after sundown or cover plant if there must be light.

JASMINUM PRIMULINUM The yellow blossoms often mistaken for forced forsythia because of bloom time and color.

LYGODIUM JAPONICUM Japanese climbing fern. This offers an interesting texture, with its trailing, curling tracery of stems and leaves for which wires or trellis should be provided. Give plenty of water.

MUEHLENBECKIA COMPLEXA Maidenhair vine. Another plant which provides delicate texture with its wiry stems and small tidy leaves.

Osmanthus fragrans Sweet olive or tea olive. Inconspicuous cream-colored blossoms have heavy fragrance September through May. Grows slowly into a small tree.

Pelargoniums of all kinds These are the geraniums of our window boxes and summer gardens, as well as dwarf-growing types and scented leaved ones (lime, lemon, peppermint, and many others) with small flowers. Let dry out between waterings, and be scrupulous about not watering in cloudy weather. This is a general rule of thumb in cool greenhouse culture, unless a plant is so dried out as to be wilting.

***Primula* spp.** Primroses. Beware that some people are allergic to the leaves of *P. obconica, malacoides* and *chinensis* particularly.

Rosmarinus officinalis Rosemary. Lovely in texture and growth habit, this is a continuing source for fresh flavoring and provides a pleasing scent when touched.

***Streptocarpus* spp.** Cape primrose. Do not overwater these purple, lavender, and white blooming relatives of the African violet.

Tibouchina semidecandra Cut back in April and pinch tips relentlessly until August to attain a maximum of the large flat, rich purple blooms in late fall and early winter.

Schlumbergera truncata Thanksgiving cactus.

S. bridgesii Christmas cactus. Cool temperature, no artificial light after sunset, and withheld water in October should assure a good show of bloom.

Bulbs for forcing: *Freesia, Anemone coronaria* These tender bulbs should be planted in eight inch or deeper pots. The small bulbs belie their need for root space.

Hardy bulbs Tulips, narcissus, crocus, bulbous iris. Cool greenhouse conditions are ideal for a long lasting show. Your dealer carries varieties specified for forcing.

***Hedera* spp.** Ivy

Soleirolia soleirolii (Helxine soleirolii) Baby's tears

Cymbalaria muralis Kenilworth ivy.

All of these plants can be used in low pots on benches or floor in front of larger pots, as a kind of mock ground cover to add a graceful appearance to your winter garden.

THE EVOLUTION OF A COOL GREENHOUSE FROM BUILDING TO BULBS

JOHN BARSTOW

On a dull-day in mid-February John Gilmore's greenhouse is a welcome sight. There is a tiny bright space jammed with the colors and scents of scores of familiar spring flowers.

Gilmore's greenhouse is a stage on which he produces a succession of glorious bloom over five gloomy months, from November through March. In any given winter week he is tending a dozen different flowering plants. Crimson and white amaryllis, drifts of butter-yellow and scarlet freesias, narcissus of many sizes and forms, and bright tulips cover practically every inch of the small bench. Tucked in among these—behind them, on crowded shelves above them, on the floor below them—are pots of pale pink, lilac, and white hyacinths; trays of lily of the valley and impatiens; cyclamen and clivias. Baskets of lantana hang from the metal rafters.

All of this midwinter color is choreographed in a seven- by 11-foot Lord & Burnham lean-to greenhouse that John Gilmore, a trial attorney, built onto his yellow clapboard house in Cambridge, Massachusetts. In 1982 when the greenhouse was constructed, Gilmore had thrift on his mind as much as blossoms. "Originally I'd planned to generate some heat for the house. But I got much more interested in gardening and much less interested in heating the house." So much so that within the year Gilmore had not only abandoned notions of economical passive-solar heat, he had purchased for the greenhouse its own furnace, a small gas-fired model installed in the basement not 10 feet from the big oil burner.

Of the energy-efficient double-glazing he had specified to the manufacturer, Gilmore ruefully comments, "Yes, there's less heat loss, but there's also a reduction in light to my plants." So much for thrift. His decision to give the greenhouse its own heat source is emblematic of his horticultural evolution. Gilmore started with modest aims suited to his limited know-how, but was quick to plunge deeper as gardening became more compelling, learning as he proceeded.

The greenhouse got off to a haphazard start. Gilmore and a friend dug the four to five-foot deep foundation hole by hand in October. A contractor poured the footings and built the cinder-block

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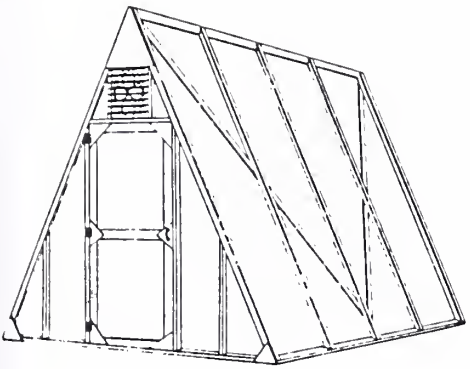


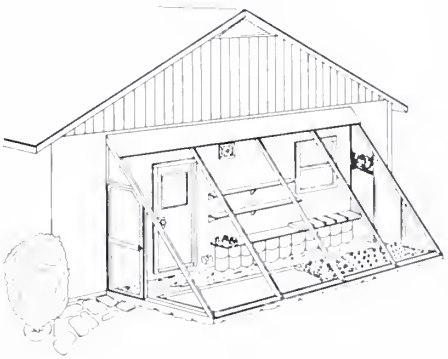
Plans such as this one and several to follow are available from: University of Connecticut. Plan no. 238, A-frame home greenhouse

foundation just before frost set in. Then Gilmore filled the hole with crushed rock, the heat sink for his passive-solar heating scheme. Once all was in readiness, the manufacturer sent a crew to erect the house itself.

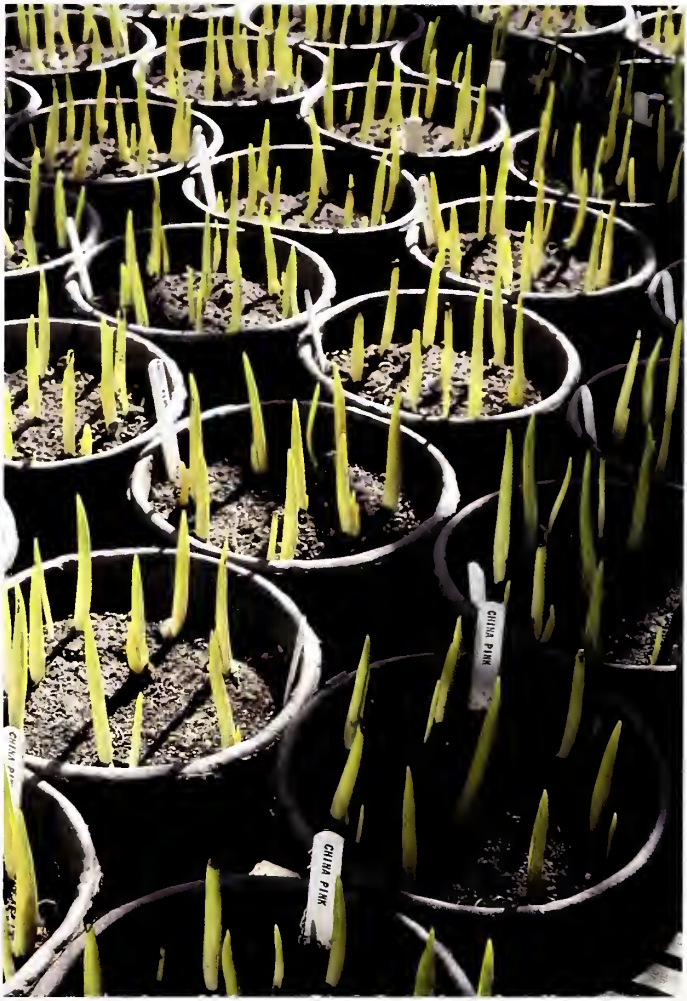
Gilmore's haste to close in the greenhouse before winter made that first season "a bit of a trial. I had no water, no heat, no floor, and no access except through windows off the living room. That spring I put in the French doors." In putting in a floor he turned his idle heat sink to advantage. Gilmore decided to leave the crushed rock exposed under the three-foot wide bench he had built against the outside wall. He finished the remainder of the floor, about half the area, in terra-cotta tiles. This arrangement affords him a clean area to stand on, while the relatively small quantity of water he uses drains through the rock. Bit by bit the greenhouse came together. "After six months of going crazy carrying water I put in a water line," says Gilmore. Eventually he installed not only running water but a mixer that combines hot and cold water in the basement and delivers tepid water to the tap in the greenhouse. Another addition, electric outlets, allowed Gilmore to work evenings: "To come home at the end of the day in winter when it's dark, turn on the greenhouse lights, and just water the plants is a joy." Thermostats, one to regulate heat from the gas furnace and a second to regulate ventilation, were installed, and Gilmore's greenhouse had arrived.

John Gilmore's greenhouse is cool. He prefers to grow hardy bulbs and other spring-flowering plants that thrive with a minimum nighttime temperature of 45 degrees and a winter daytime high of 60 degree. Even though the bulbs tolerate slightly lower temperatures, Gilmore maintains a minimum nighttime temperature of 50 degrees in deference to tender perennials like tropical hibiscus. He closely adheres to the 60 degrees maximum temperature, however, since more heat would speed growth and substantially shorten the life of each blossom.

Gilmore's gardening seasons more nearly resemble those of New Zealand than New England. Sometime in August, when gardens (and gardeners) hereabouts are looking a little worn out, Gilmore is setting the stage for his midwinter blitz. That's when he sows his first two or three pots of nasturtium seed. For the next six months, every four weeks, he sows another two or three pots of nastur-



Attached greenhouse (a solar collector), University of Connecticut Plan no. 252

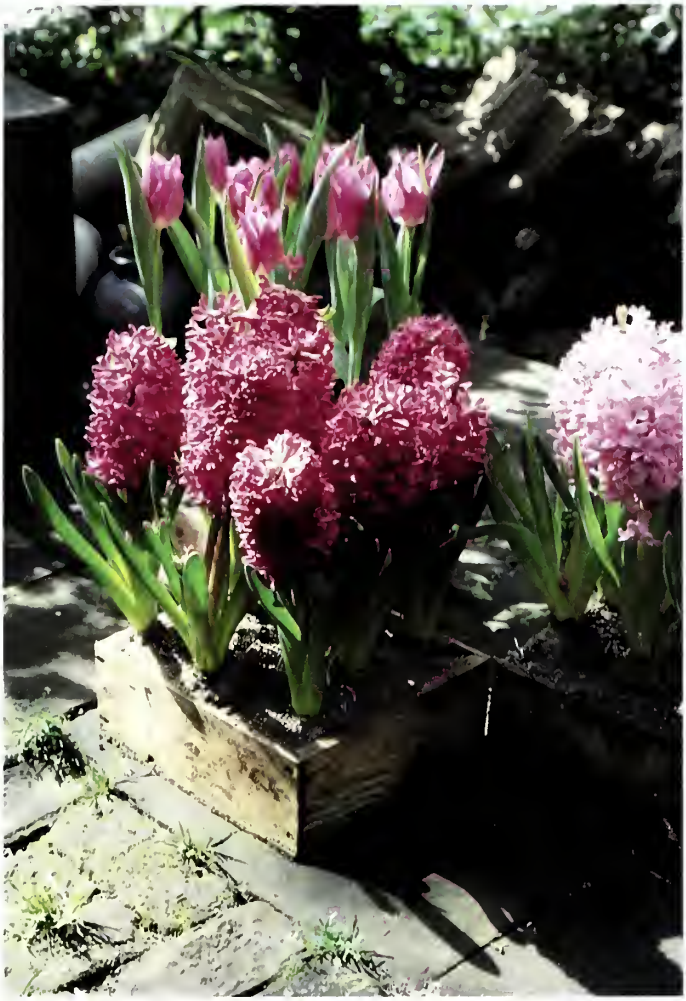


Tulips sprouting after being treated to a cool period.

tiums so that he'll have some of these "filler plants," as he calls them, in bloom right through until summer.

Housekeeping is the next step in his carefully orchestrated chain of events. Before he returns his tender potted perennials to the protection of the greenhouse he scrubs down the works, including glass, walls, floor, bench, shelves, and each of his clay pots. All these being thoroughly cleansed, he sets off an insecticidal bomb in the greenhouse, closes the doors, and crosses his fingers in hopes for another relatively pest-free year.

Finally, the plants enter the scene. Tender perennials that find a place in his greenhouse include a four-year-old cattleya orchid; two tropical hibiscus that produce saucer-sized scarlet flowers all winter and spring; a jasmine "I've never persuaded to bloom;" a camellia; pelargoniums, cut back and made to bloom again; an azalea; cyclamen, "fabu-

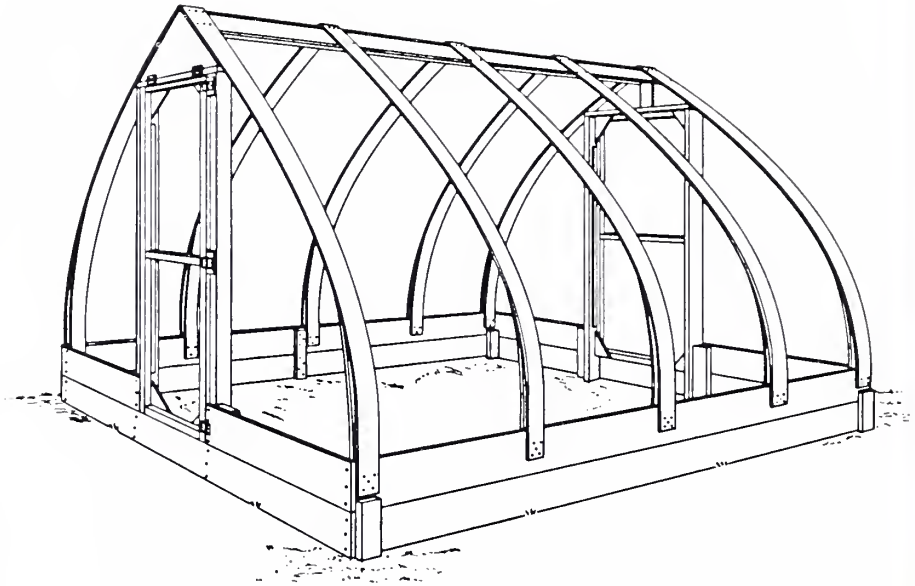


Hyacinths and tulips can be forced for winter color.

lous plants for a cool greenhouse that give me two months of good bloom in winter;" several agapanthus and clivias; lantanas and a venerable rosemary.

The larger potted plants occupy the floor along the wall of the house, where there is somewhat less light and temperatures are slightly cooler. The agapanthuses, which are wintering over in the greenhouse, live beneath the bench, where there is even less light. Every greenhouse has cooler spots, and Gilmore uses his wisely. These established plants needn't occupy the precious growing area on the bench, and they admirably fill out corners that would otherwise be bare. The jasmine and lantana occupy hanging pots.

With the arrival of September comes Gilmore's busy season. He begins potting up the hundreds of bulbs that will bloom through the dark months ahead. In the annual replacement of bulbs, Gilmore is extravagant; he saves few—mostly



United States Department of Agriculture Plan no. 5946

amaryllis—from year to year, believing that bulbs once forced are not likely to come on strong the second year. The following 90 days are punctuated by weekends down in the basement, where a corner is given over to the implements and ingredients of the potting shed; stacks of terra-cotta pots of every size and description, seedling flats, as well as bales of peat moss, huge bags of perlite, sacks of sterile potting soil and sand.

At the far end of this jumbled corner is a small wooden door that leads through the brick foundation to a dark, cool, low-ceilinged room about six feet wide and twice as long. At its far end another door leads outside. This curious anteroom is the heart of Gilmore's little operation. It is a ready-made root cellar far enough from the cellar proper to provide the cool temperatures he needs to chill his bulbs. On a typical mid-November evening the room contains some 70 clay pots stuffed with bulbs.

Manipulation of light and temperature is the key to tricking plants to do unnatural things, and this is where Gilmore's cold room comes in handy. In it he holds bulbs in darkness at between 45 and 33 degrees F (never below freezing) for anywhere from 10 to 15 weeks, the chilling period required to make hardy bulbs think they've been through winter. During this apparent dormancy they make good root growth, which equips them to produce blossoms once they are moved up into the light. Gilmore also purchases precooled bulbs which are ready to go into the greenhouse in two to four weeks, depending on how long he chooses to hold them in abeyance, and they blossom at least four weeks earlier than other bulbs.

Without this cool room Gilmore would be unable to trick his hundreds of bulbs into blooming over the course of the winter. "It's a little hard to control. I pot them over a long period but, still, when bulbs are showing several inches of growth I can't hold them any longer, I have to bring them up to the greenhouse. Bulbs newly arrived from the cold

room go under the bench for a week to acclimate to the warmth and light of the greenhouse.

Once his spring-flowering bulbs begin their display in mid-December Gilmore spends more time in the greenhouse and less in the basement. He has only to water the plants regularly, fertilize occasionally (he top-dresses with an all-purpose fertilizer), keep an eye out for pests, replenish the supply of bulbs as early arrivals fade and another batch is ready to be removed from the cold, and see to it that the temperature stays within bounds. By March lengthening daylight and the higher angle of the sun begin to threaten his collection with too much heat. "In March I begin to use a fan to get the hot air out. A problem with small greenhouses is that temperatures change rapidly."

April and May mark the beginning of the end of Gilmore's greenhouse year. He sows seeds of annuals (impatients and marigolds, mostly) that will be planted in the garden for summer bloom and gives the house its spring cleaning. To accomplish all this Gilmore figures he puts in around five hours per week from September through May. Roughly speaking, he spends two hours Monday through Friday watering and generally looking after the plants. The remaining three hours are alloted to weekend tasks like potting bulbs, sowing seed, moving plants in and out of the greenhouse, and spring and fall cleaning.

Summer is "pretty bare bones," he says. "This past year, though, I used it to better advantage. I started tuberous begonias in late spring and they bloomed all summer." So continues John Gilmore's progress. He is always trying new plants, and he is always experimenting with greenhousing. In fact, he has plans for a large porch at the southwest corner of his house. It will be fitted with floor-to-ceiling, double-paned glass. Though he prefers to call it "my glassed-in porch, "it will amount to a conservatory. Needless to say he has great plans for it, but he is proceeding one step at a time.

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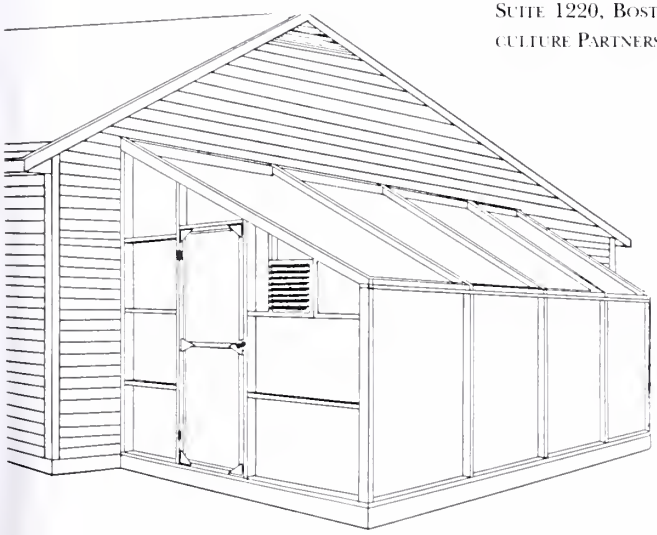


Lean-to greenhouse, University of Connecticut Plan no. 248

CUT FLOWERS FOR COOL GREENHOUSES

JAMES STEVENSON
WITH ASSISTANCE FROM
DEBORAH MATTHEWS

Carnations, chrysanthemums, stocks and snapdragons have been popular as cut flowers for many years. All are relatively long-lasting as cut flowers and all thrive in cold greenhouses that require less energy to heat during the cold months of winter. Although only a handful of plants have attained international fame as cut flowers, there are many more that are equally appropriate.

In our estate greenhouses on Long Island, we work with many cut flowers that can be grown in a cool greenhouse (maintained at 45 to 50 degrees F at

JAMES STEVENSON *is a gardener on a private estate on Long Island, New York.*

Many of the cut flowers seen in flower markets can be grown in a home greenhouse.

Most flowers grown for cutting thrive in a cool greenhouse.

night with good unobstructed light, or in an unheated frame that can be covered with a layer of heavy mil clear plastic. In particular, we have had success with the following cut flowers.

Annual *Gypsophila* or baby's breath is easily grown in soil-filled flats or other shallow wooden boxes. Seed planted thinly, or thinned after germination, sprouts readily and grows quickly. Starting a new flat with seed every two or three weeks from January 1st will provide continous cutting material for many weeks in spring.

Another highly recommended cut flower is *Saponaria vaccaria.* This is very similar to baby's breath, but pink. It is available from some of the English seed houses (such as Sutton's). Its sturdy stems will reach two-and-a-half feet, and the flowers make a pleasing contrast with the white baby's breath in bouquets.

Another annual for spring flowers that can be grown in flats is the blue lace flower, *Trachymene caerulea,* which has blossoms similar to Queen Anne's lace. All of these annuals can be grown in flats with several sowings to extend the cutting season.

Nemesia makes a charming cut flower when grown in four-inch pots. Seed should be sown in seed trays in August, transplanted into small pots when several leaves appear, and then potted up into the finishing pots. It will flower from January until March if grown in cool and sunny situations. The colors, which range from white to yellow and red are vibrant, making very pleasing small arrangements. Their stems will usually vary from six to 12 inches. A second sowing in December will produce flowers from April until June. *Nemesia* 'Blue Gem,' available from Sutton's, is a particularly noteworthy variety with small flowers that range in hue from dark blue to a blue so pale it is nearly white.

Another small flower suited to growing in four-inch pots is *Linaria.* 'Northern Lights' is a recommended variety available from most catalogs. Grown from seed started in August in seed trays

and later transplanted into small pots before being moved into four-inch containers, it will start to flower in November and continue until May. The flowers, which come in a wide range of colors, are like very tiny snapdragons and are produced on thin, delicate stems that need support either with bamboo stakes and strings, or branched twigs from shrubs.

If you can plant starters directly in the benches of your greenhouse, you can produce a good crop of calendulas for cutting. Calendulas do best in a very cool, sunny house. Seed should be sown in August (use the tallest varieties available), transplanted into small pots, and then planted into the bench. Since they will flower for three to four months, give them at least ten inches between plants. The first flowers should appear in October or November and will be largest if the side buds are pinched off each stem as the buds begin to enlarge. Whitefly can be a problem with calendulas, but constant attention will keep that pest under control.

When grown cool, given support and planted in the benches, annual candytuft will produce tall, strong stems carrying large, flat clusters of white, pink or red flowers. The large whites are the most popular florist's variety, but the white/pink/red bedding plant mixes (such as 'Fairy Mix') also produce charming cut flowers. Seed can be sown in trays in January, transplanted into small pots, then planted directly into the greenhouse bench where they should flower in May. Earlier or later sowings provide a somewhat longer blooming season, but June weather renders the greenhouse too hot for these cool-loving early cut flowers.

Godetia makes an outstanding cut flower. Seed is sown in January in trays, transplanted into small pots and then planted in a bench in March. In fact, you might try planting godetias in the calendula bench after that crop has been pulled. 'Sybil Sherwood,' available from Sutton's, is a popular variety with lovely salmon and white flowers. Though the petals of godetia appear to be delicate and easily bruised, the flowers continue to open over a long period of time. Damping-off and other soil diseases can be a problem with godetias, but starting with a sterile seed-sowing medium and careful attention to watering, ventilation and temperature will give good control.

Ammi is a charming white flower borne in large flat clusters very similar to Queen Anne's lace. If seed is sown in January, then transplanted into small pots before benching in March or April, flowers may be expected in May. *Ammi* must have plenty of support, as the plants can easily reach five feet. Equally suitable and requiring similar cultivation techniques are bachelor's buttons and sweet sultans. If treated like *Ammi*, they reach an equally tall height and will flower until hot weather arrives in later spring.

Two old-fashioned favorites for wintertime cut flower bouquets are buddleia and stevia. These two must be grown from cuttings rather than seed. Stevia (*Piqueria trinerva*) has tiny white flowers that are sweetly fragrant. *Buddleia asiatica* has long slender spikes of fragrant white flowers while *Buddleia officinalis* has shorter spikes of fragrant lavender flowers. Cuttings can be taken in March or April and grown in pots either in the greenhouse or outdoors in a cold frame during the summer. Occasional feeding and pinching will produce healthy, bushy plants. Before frost threatens, they must be brought into a sunny, cool greenhouse (45 degrees F is sufficient) where they will flower. Although these cut flowers are otherwise easy to grow, they are prone to attacks by whitefly.

Many bulbs are ideal for growing in a cool greenhouse, particularly if you have

a cold frame or root cellar available for storage, or a spot outdoors where the flats or pots of bulbs can be buried under peat moss or sand. Tulips, hyacinths, crocus and narcissus are familiar to all gardeners. However, indoor gardeners should also experiment with iris, freesias, ornamental onions, ornithogalums and lilies. As with all bulbs to be used for forcing, the grower should purchase the largest and best quality bulbs available.

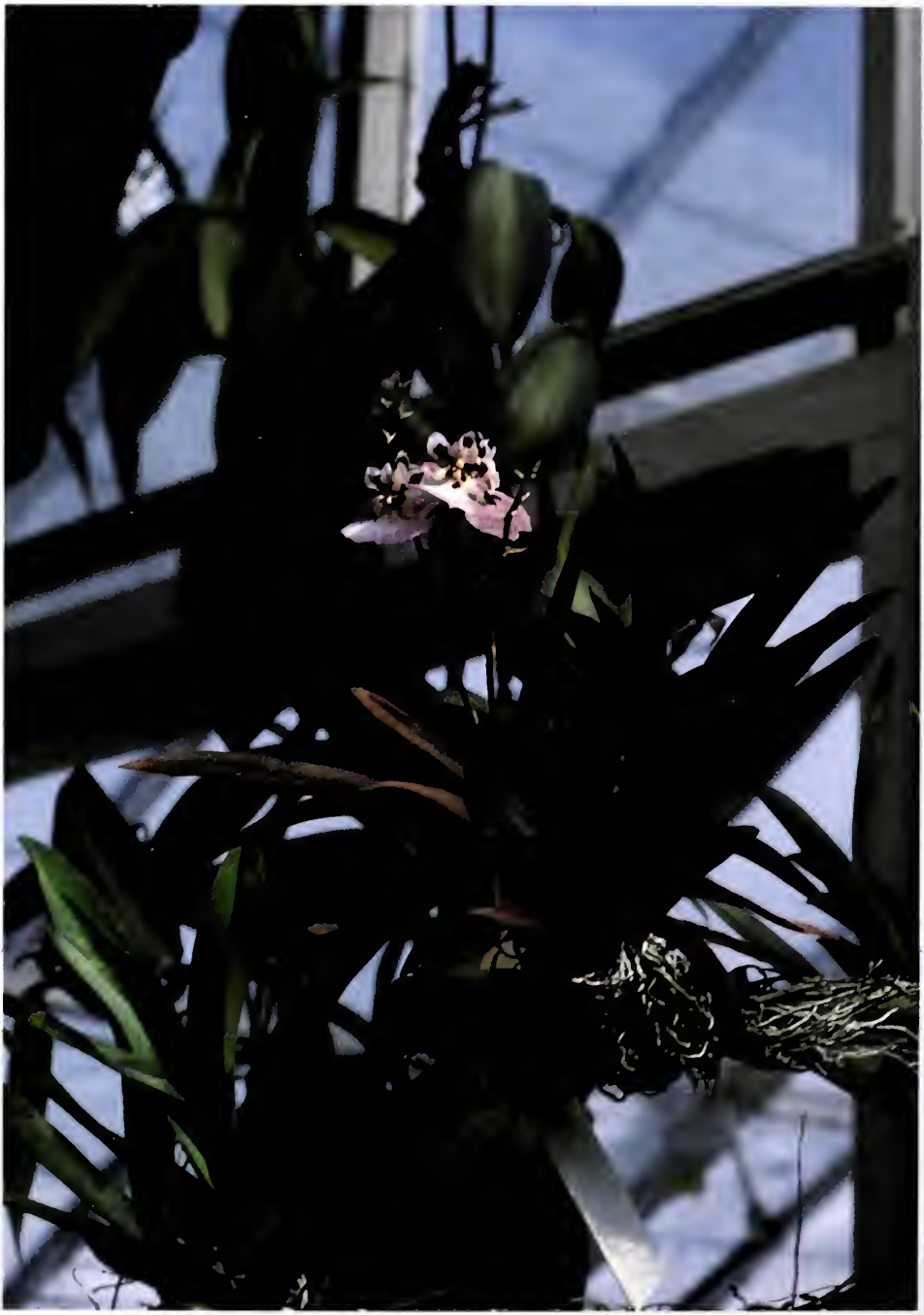
The florist's iris are easy to care for as long as good ventilation is available. Iris bulbs that are not prepared for forcing should be placed in a four-inch-deep wooden flat and stored in a cold frame for several months to allow good root growth before being brought into the greenhouse. If the bulbs are "flatted" in November, they are usually ready to be brought into the greenhouse by February or March. Bulbs that have been prepared for forcing can be flatted and put into the greenhouse immediately. Be careful with your watering, allow space between the flats for extra air circulation, and do not move the flats once the buds are showing. Any damage to the roots may cause the buds to blast. Blue or white iris are usually the best varieties for forcing under glass; the yellows tend to have weak stems when grown indoors.

Freesias do not require any special handling before planting in the greenhouse. In addition, staggered planting throughout the winter will give you a long season of bloom. The most satisfactory flowers will be produced in cool greenhouses with bright light. Freesias can be planted either in pots or in the bench. In either case, staking is necessary to prevent the foliage and flowers from flopping. Not only are freesias easily grown, but their bright colors and fragrant flowers are favorites during the cold months of the year.

Ornamental onions are also attractive and easily grown. *Allium moly* has a small yellow flower perfect for arrangements. The white *A. neapolitanum* or the improved *A. cowanii* are even nicer as cut flowers. Their bulbs are simply pressed into the surface of the soil and placed in a cool greenhouse. Bulbs planted in November and grown at 50 degrees F nighttime temperatures will usually flower in February and March. A more carefree bulb for greenhouse forcing is hard to find.

Ornithogalum arabicum is a fascinating plant in the lily family. The white flowers, each one and a half to two inches across with a black pistil in the center, are held in clusters at the top of strong one-and-a-half- to two-and-a-half-foot tall stems. Ornithogalum bulbs can be grown individually in four-inch pots or planted together in flats. A root-forming period in a cold frame or a cool, protected spot should precede their placement in the greenhouse where they will flower. At 50 degrees F nighttime temperatures, they will usually flower in March and April, although they can be coaxed into bloom earlier if grown at 60 degrees F.

Lilies are spectacular flowers that can be grown during late winter and spring to make large, colorful arrangements for the house. They are relatively easy to force in a cool greenhouse, provided you begin with precooled bulbs, sterile soil and clean pots, and do not overwater. The lilies most commonly used for forcing are the Asiatic hybrids such as 'Enchantment' (red-orange), 'Connecticut King' (yellow) or 'Firebrand' (red), though many others are available. For forcing, several bulbs are planted three to four inches deep in a large pot. If precooled bulbs are planted in December, flowers can be cut in March. Planting a few bulbs every three to four weeks will provide cutting material over several months of spring.



Oncidiums growing in the greenhouse at Planting Fields, Long Island, New York.

THE ORCHID GREENHOUSE

CHARLES MARDEN FITCH

When orchids are to occupy most of a greenhouse, the interior design must accommodate these unique tropicals. I find most orchid growers enjoy having a collection of many genera. My own collection contains genera from around the world; their mixing is successful when each orchid is placed according to its special needs.

Layers

In a typical orchid-region of tropical Asia or Latin America, orchids grow in three major levels. On the ground, in deep leafmold or on mossy rocks, terrestrials such as *Paphiopedilum* and *Anoectochilus* grow in low light while reed-stem *Epidendrum* and *Eria* thrive in sun.

Higher up, on tree trunks, steep rocky banks or tree crotches, live many showy genera such as *Oncidium* and *Phalaenopsis*. Finally, on fully exposed rocks, treetops and sunny limb tips dwell orchids that need maximum light and excellent air circulation. These include species of *Ascocentrum*, some *Laelia*, *Vanda* and *Schomburgkia*.

CHARLES MARDEN FITCH, *Mamaroneck, NY, an international horticulturist and media specialist, studies orchids in their tropical habitats around the world. He is author/photographer of many books including* ***Garden Photography*** *and* ***All About Orchids****, and guest editor of several* ***Plants & Gardens*** *handbooks.*

Top to Bottom

I adapt this natural multi-level approach to habitat to fill available space top to bottom in the greenhouse. Hanging from the rafters are orchids that need maximum light. Under the highest hanging post are those of younger orchids and genera that do well with less-intense light. On the greenhouse bench are seedlings and orchids that will bloom with the dappled light that gets through the canopy above.

Orchids need more intense light than many other popular ornamental tropicals. When you have a choice about greenhouse placement, always select an orientation with maximum sun exposure, then control intensity with shade paint, rolling shade cloth or blinds.

In my lean-to greenhouse, a wall of the house blocks the sun after mid-afternoon. As it gets less than maximum

sun, I supplement the natural light with fluorescent lights. To better grow orchids against this inside wall I hang fluorescent fixtures with broad-spectrum lamps over the plants.

Under the benches I put more fluorescent fixtures so orchids can actually be grown from the floor level on up to the roof glass level. Without the supplemental fluorescent light under the inside benches, very little would grow well. Under the outside (lighter) bench one might grow terrestrial jewel orchids or similar orchids with low-light requirements. In my situation I'd rather have the flexibility of growing many genera under the benches, even though it means a higher electric bill.

Multi-Story

Some orchid growers use a two-story greenhouse if room permits. By constructing a spiral staircase and an overhead walkway, one can build a two-story greenhouse where hanging orchids fill the top story. Below, growers can create conventional raised benches at waist height. This sort of design permits many plants to fit inside a greenhouse although the actual ground footage is limited.

With this approach it is most important to have adequate air circulation. I have several small fans operating 24 hours per day, circulating the air but not blowing it directly at orchids. Aim a fan up at the roof, against a wall, or at the floor. One of my humidifiers also has a fan that goes on low speed all the time, then switches to high speed when the mist comes on.

Another way I get air circulation in a lean-to greenhouse is by using a small muffin fan to blow warm air from the house basement into the greenhouse, slightly above floor level. The air in my basement is warm because that's where the natural gas furnace, water heater, and washing machine are located. In cold weather the air helps heat the greenhouse. In warm months the basement is usually cooler than outside so the same system helps keep the greenhouse cool.

Micro-Climates

Since my favorite orchids like an intermediate to warm greenhouse (usually above 60 degrees F at night), I use micro-climates to accommodate genera that do best with cooler nights. For example *Odontoglossum* spp. grow well for me if I keep them under an outside bench where the air goes down to about 50 degrees on cold winter nights. Orchids that do best with warm nights, for example *Ascocenda* spp., thrive when I hang them at the end of the greenhouse nearest the heaters. Use a maximum-minimum thermometer to find micro-climates. Here are some orchid greenhouse details adapted from my book *All about Orchids*:

Shading

Some form of shading is often needed during summer months. Inexpensive shade paint compounds are used by many commercial growers but are rather messy for home use. I prefer to diffuse hot summer sun with frosted fiberglass panels above the greenhouse roof. Greenhouse supply firms and many orchid nurseries also sell shading fabric in various mesh sizes to give different percentages of shade. For example, a collection of mainly phalaenopsis orchids would need more shade protection than one of vandas or cymbidiums.

A modern way to share orchids is by electronically-operated roller blinds that come down over the greenhouse roof or roll out under the glass above the plants as temperatures rise. Such electric controls work well on thermostats so

orchids can be left alone with no fear that they will burn if a cloudy spring day suddenly turns sunny.

Humidity

Most orchids do best with 50 to 60 percent humidity. The orchid greenhouse should have an efficient humidifier attached to a main waterline for automatic operation. Place the humidifier so that its mist or fog has several feet of free air space before it hits the plants. Orchids too close to a humidifier may be kept too wet for their health.

Another way to increase humidity, useful on dry windy days, is to soak the floor and mist the plants. I like to use a sturdy metal watering wand called "FoggIt." The "FoggIt" comes with two nozzles. The fine mist is good for lightly wetting plants on bright mornings while the coarser nozzle is excellent for soaking the roots or wetting the floor.

In the cold weather when my "Southern Burner" natural gas stoves are working almost constantly I put a metal baking pan filled with water over each stove. As the water heats it evaporates, thus adding to the humidity.

Heating

My greenhouses are heated by natural gas "Southern Burners." One model is vented through the roof via a three-inch stovepipe. Orchid buds blast easily in polluted air so vented heaters are best for orchid greenhouses. In another greenhouse I have a non-vented, open-burner heater but the orchids still thrive since fresh air is constantly introduced to the greenhouse through floor vents and the basement-to-greenhouse fan described earlier.

Electric heat is efficient and safe for orchids but too expensive and unreliable in my area of the Northeast. If I were to build a greenhouse from the ground up, I would use only vented natural gas heaters or a hot-water system with the water heated in a natural gas burner.

Air Cooling

Air cooling is required for greenhouses when outside temperatures are high. Sun beaming through the glass or plastic will heat up interiors very rapidly, a good thing in cold weather but dangerous for plants if temperatures get too high. Most orchids can survive summer days of 90 to 100 degrees F as long as humidity keeps pace with the heat. Relative humidity *drops* as temperatures rise so in hot sunny weather the humidifiers will be a great help in protecting plants. Having adequate vents is also good. I like automatic roof vents that open when inside temperatures reach 85 degrees F.

In parts of the country where summers are not too humid, orchid growers use evaporative coolers to lower greenhouse temperatures. Dry outside air is drawn over a wet fiber mat by a big fan. As the air goes through the wet fibers it is cooled and humidified. This system works well in areas like Southern California but isn't efficient where outside air is humid. Growers in the Northeast often use regular air conditioners to help their orchids get through summer heat waves.

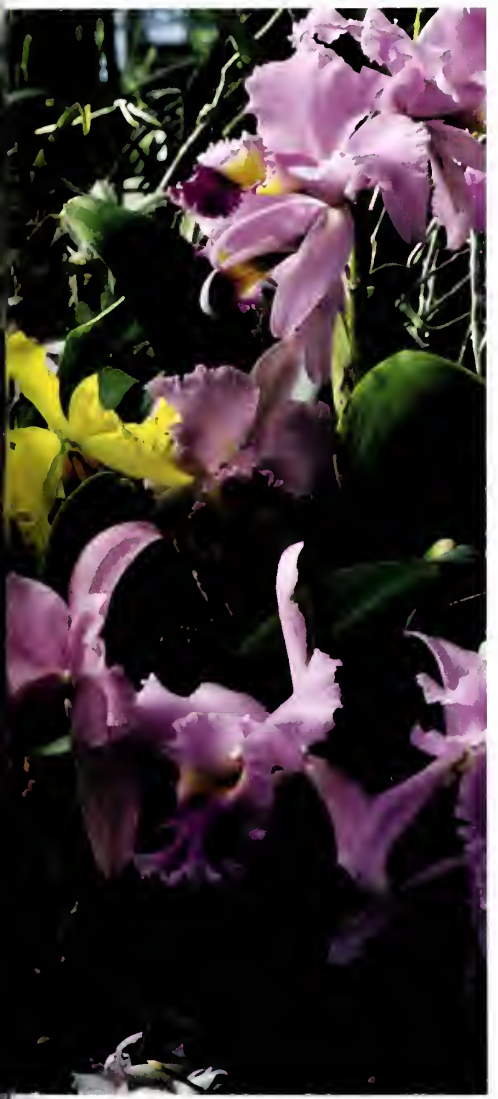
Summer Vacation

The hundreds of orchids in my greenhouses are too crowded so I give them a summer vacation outdoors. When the warm weather stabilizes I move many of them outside, where they live under tall oak trees until September. Cool-growing orchids are the first to go out and the last to be brought in. *Dendrobium nobile* hybrids and standard *Cymbidium* orchids require fall nights in the 50's if they are to bloom well. I leave these types outside until just before a frost. Warmer growers come in by early September.

Some orchid growers have sun-rooms or greenhouses where one or more walls can be opened up in warm weather. This system, along with putting plants outdoors, works where summers are humid but would not be good where humidity is below 50 percent.

Commercial and home orchid growers differ in the way they use greenhouses. The commercial growers frequently fill a greenhouse with one or two genera, the plants being neatly spaced on raised, ventilated benches.

In contrast, the home orchid grower fills a greenhouse to overflowing, usually with a well-diversified assortment of genera. This is a good idea since a multi-genera collection can have something in



An array of cattleyas shows their many forms and colors. Their striking flowers are long lasting.

bloom every day of the year. The disadvantage to this year-round love of beauty is a jammed greenhouse.

My final suggestion, from one who admits to having an overcrowded collection, is to build a greenhouse double the size you THINK is adequate. In a few seasons you will be pleased to have the space.

A SCHEDULE FOR GROWING CUT FLOWERS IN THE GREENHOUSE

JAMES STEVENSON
WITH ASSISTANCE FROM
DEBORAH MATTHEWS

Just as a garden should be designed on paper before applying spade to soil, a plan for producing cut flowers over a long season is equally important. To create a successful schedule for forcing cut flowers, consider the numbers of plants, seedlings or bulbs needed, and the area of bench or bed available.

A schedule is particularly important when forcing bulbs. Try to plan as much of your yearly bulb-growing needs as possible on paper before starting the project. Look through bulb catalogs for ideas of what varieties are available. Bulb suppliers will not be anxious to spend time answering your questions in September or October when they are over-extended. They are often happy to help, however, if contacted during the summer when their business is slow. They can give advice on how best to put together an order that fits your individual needs, including the scheduling of delivery dates scattered throughout the season for various planting times. Be sure to discuss shipping methods, especially if you plan mid-winter deliveries. Not all carriers can ensure the fast service necessary to prevent frozen shipments.

Starting in the spring, an unheated, plastic-covered frame house can be used to produce a great variety of cut flowers from early April until late June. After that date, you can rely on outdoor plantings of annuals and perennials to yield flowers for the house. A frame house can be made with metal pipes or wood, constructed over fertile ground, and the flowers grown directly in the soil.

The frame house provides minimal protection. It allows you to put plastic over the bed, extending the growing season by providing some protection from frost, wind and rain. A curved-top frame house is better than a square design for this purpose because there will be less damage to the plastic from ice and snow. Posts set into the ground around the perimeter of the bed permit supports to be put up for the taller growing flowers, such as snapdragons.

Bulbs and tubers such as tulips, anemones, ranunculus and florist's iris can be planted in the ground in October or November. At this time the plastic covering is not necessary. However, it will be required for spring crops, and is more easily installed in the fall. Cutting from bulbs will begin in April for anemones and tulips and continue in May for iris and ranunculus.

Once danger of hard frost is past,

seedlings that have been started indoors and hardened off outdoors can be planted in another section of the frame house, usually in mid-to late-March.

Some crops which can be successfully grown this way are stocks, snapdragons, bachelor's buttons, calendula, larkspur, annual scabiosa, matricaria and annual chrysanthemums ('Eastern Star' is an old favorite and a good producer). These seeds should be sown in seed trays in January or February; they can be transplanted into small plastic pots or peat pots when several true leaves have appeared. Peat pots can be transplanted directly into the soil bed in the plastic house. However some plants, such as snapdragons, resent being transplanted into peat pots.

The quality of the cut flower plants grown under plastic, and left unheated in the early spring, is often better than the same plants grown outdoors later in the season. Each produces best under cool growing conditions, and the plastic covering will protect the flowers from all weather damage except a late, hard frost.

Watering, occasional fertilizing, staking or other support, venting when the temperatures rise, and watching for aphids are all crucial factors in producing good cut flowers. The plastic house must be checked everyday for watering and venting. A grower will experience the best results if he keeps the house open as much as possible. An occasional feeding with a water-soluble fertilizer will keep your plants growing.

If supports are necessary for your crop, it is a good practice to erect the supports when the seedlings are set into the ground. Open wire mesh or plastic mesh is very efficient and easy to put into place. It can be purchased in three-foot or four-foot wide strips and stretched over cross-bars above the planting bed. Some of the taller plants may require a second or third layer of this support. Scratching the soil with a cultivator every few weeks, or mulching with black plastic, will keep the weeds under control—this is necessary to ensure the healthiest flower-producing plants.

In spring, as the temperatures rise, you should cut more air vents in the plastic. By June it may be necessary to remove the plastic entirely.

In mid- to late-June, when outdoor beds are beginning to produce, the plants inside the frame house can be pulled out and discarded or put on the compost pile. Soil should be improved for the next crop of flowers, which might include tall mums planted in July for cutting in October and November. Before the first frost arrives in fall, cover the frame with new plastic to protect the mums. When they have ceased to flower, or have been finished by a hard frost, prepare the bed for early spring bulbs.

With experience you can enjoy cut flowers in your greenhouse over a long period of time by carefully scheduling seed-sowing dates, planting and flowering dates, and removal dates. Chrysanthemums, snapdragons, and paperwhite narcissus will yield cut flowers in the fall. Calendulas, stevia, buddleia, snapdragons, stocks, nemesia and linaria flower during the midwinter months. Bulbs such as ornamental onions, lilies, tulips, narcissus, iris, freesias and godetia, baby's breath, ammi, centaureas and candytuft will flower in early spring. For later spring flowering, all of the plants in the unheated plastic house will yield lovely flowers for bouquets.

One last word of advice—keep records of the year's activities such as seed sowing, transplanting, benching or flatting dates, first and last cutting dates, spacing and numbers of plants or bulbs used. All of this information will be invaluable for scheduling the following year's cut flowers.

PLANT PROPAGATION

BOB WEIDNER

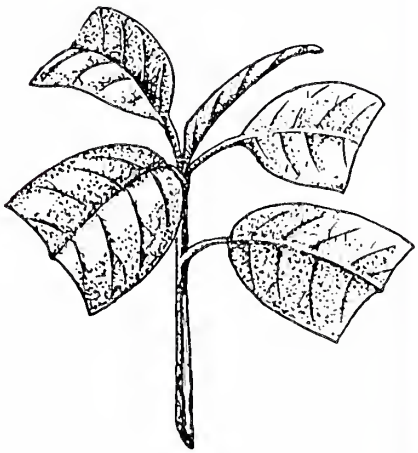
The propagation of plants is a source of great pleasure for plant lovers. Nothing quite equals the joy of producing new plants. From start to finish, propagation is the product of your own skill and efforts.

Plant propagation is a vast topic, and professionals employ many different techniques—too many to discuss in a short article. To give you some idea of the diversity of propagation techniques, Volume I of Bruce MacDonald's *Practical Plant Propagation* has no less than 634 pages devoted to the subject. Let us limit ourselves to rooting vegetative cuttings in the home or small greenhouse. Anyone who truly enjoys gardening should not hesitate to try his hand at this method of reproducing plants.

When propagating plants in the home, it is important to start with the right attitude. Do not expect 100 percent success with your cuttings. Rooting even a few cuttings on your first try should be considered a "success". At each attempt, you will get a little better. Concentrate on your successes and forget the failures.

As in every aspect of gardening, preparation and planning gives the most successful results. First, one must prepare the structure in which the cuttings will be rooted. There are innumerable types in use.

The best structure is a small greenhouse equipped with three-foot-high benches. It should have an intermittent mist system over each bench, with mist lines which can be valved off in several sections. It should be shaded down to



Large leaves can be clipped to about half size to allow more cuttings per unit of area and to reduce surfaces from which the cuttings can lose excessive water.

ILLUSTRATIONS BY PETER NELSON

BOB WEIDNER *of Leucadia, CA studied under T.H. Everett at the New York Botanical Garden and was past president of the Western Division of the International Plant Propagator's Society. He was the owner of Weidners' Begonia Gardens, Inc.*

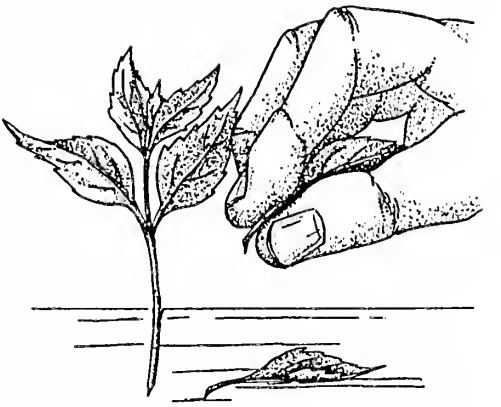
2000 foot candles, measured midday on a bright day. An easy test is to move your hand back and forth over the surface of a bench on a bright day at noon. If the light is correct, you should almost but not quite be able to see the shadow of your hand.

Second best is a polyethylene tunnel house. There are unlimited designs of these houses and they can be put to a variety of uses. My favorite design is quickly constructed. Have a piece of ground levelled 12 feet wide and as long as you wish your house, up to 21 feet long. At the 10 foot mark, lay two 1" x 12" boards lengthwise ten inches apart and fasten them upright with stakes driven into the ground. Place 20-foot plastic pipes every five feet, bend them into hoops and attach to the 1" x 12" boards. Then cover this frame with polyethylene sheets. The plastic sheets are fastened to the 1" x 12" boards with laths and six-penny nails.

The open ends are then covered with a plastic sheet fastened at the top and rolled up on an 11-foot piece of 1"x3" wood. This will allow a walk-in space for cleaning and also for venting when the house gets warmer than 85 degrees F. The entire tunnel should be shaded to 2000 foot candles measured on a bright day at noon.

To further prepare your structure, spray the empty house and ground with a strong clorox spray. You will need to use two inches of one-quarter inch crushed rock on the ground to keep your flats off the soil. Finally, install two mist lines controlled by a time clock for even misting.

Both of these structures are for the serious home propagator. But the same theories can be scaled down for the small house propagator. Very small "mini-greenhouses" can be purchased. Or a very small plastic tunnel house can be made just as easily as a large one. Simply bear in mind that the reason for any

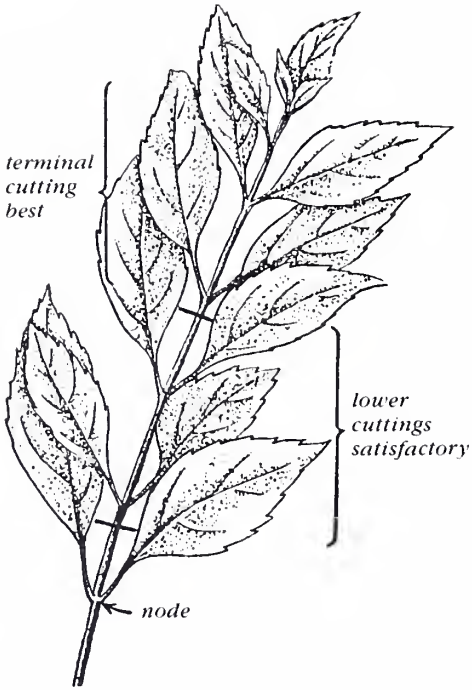


The leaves on lower third of cutting are removed.

greenhouse propagating structure is to increase the humidity in the air so that the cutting will not dry out before it has made roots. Even a single pot can be made into a mini-greenhouse. Insert your cuttings, water them and cover the miniature greenhouse by placing a clear plastic bag over the top and fastening it around the rim of the pot.

Next you must provide a rooting medium. It should be lightweight, well-drained and evenly mixed. A mixture of sand and peat is often used, and vermiculite and peat is also popular. But both these mixes tend to hold more water than the ideal medium; and retained water tends to promote decay on the basal end of the cutting. Instead I would recommend peat moss and perlite, in even amounts. Add Osmocote time-release fertilizer at three to four pounds per cubic yard. For convenience sake, prepare enough so you can use it on other occasions. Use a shovel or a small cement mixer to get a thorough mixing.

Take a metal container such as a roasting pan and fill it with soil. Insert a meat thermometer into the center of the soil mass and place it in the oven. Raise the



Terminal sections are best for softwood cuttings but long shoots can be cut into several sections.

temperature to 160 degrees F and hold it there for one-half hour; then let it cool. If it is too dry, moisten it lightly. The balance of the soil should be put in a large plastic bag, tied tightly and stored until needed.

Next we must think of tools, containers and materials. A very sharp knife and pruning shears are essential. Dull knives and shears tend to crush cuttings. Knives, shears and all other tools should be sterile. In the case of scarce and valuable plants, it is often wise to run knives and shears over an alcohol flame. For less crucial work, a dip in strong clorox suffices. A dibble to make holes for inserting cuttings is an aid, but a common lead pencil will do the job if only a few cuttings are being made. For larger lots, a pointed piece of dowel rod one-quarter by eight inches does a good job.

A hose with a mist nozzle or fine rose nozzle to water-in cuttings is essential. In addition, some nursery flats (the quantity depends on how many cuttings you wish to make) are the best containers. Again, they must be clean. A handy way to sterilize flats is to put a piece of polyethylene sheeting on the ground, place the flats on it, then bring up the sides and tie them to form a tank. Fill the tank with a mix of the ratio of 1:10 clorox to water, being sure to cover the flats. After ten minutes the flats will be sterile. Be careful not to reinfect them.

Next fill the flats with empty two or two-and-one-half inch plastic, clay or peat pots. These are then filled with sterile soil. By this method, you will have a plant with an intact ball of roots and soil, ready to continue growing on with the least amount of shock.

Having accomplished all of this preparation, you are ready to begin the actual cutting. It is very important to carefully select cutting wood. Why bother to multiply a plant with poor color, bad form or no vigor? Select a plant that has sufficiently mature growth, but not hard wood. Hard wood cuttings are another class, not to be confused with this section. We want wood that is beginning to firm up. But, in most cases, cuttings should be made before flower buds form. Many plants with flowers will root, but they usually make weaker growth as a result. Other plants, such as impatiens and begonias, only develop flowering growth and will not become bushy plants if cuttings are taken in the full blooming stage.

Take your cuttings just below the first or second fully opened leaf, and cut off that bottom leaf. To prevent infection, no leaf should be touching the soil when inserted. If a mass of leaves are crowded

at soil level, it is an invitation for Botrytis and other serious diseases.

If you are taking a large quantity of cuttings, be sure to keep them moist by placing them in the greenhouse under mist or in the shade and covered with a wet sheet of newspaper before insertion.

You will need two dipping materials, one to speed rooting and one to help prevent disease. Rootone or Hormodin may be put in a shallow saucer. However, many gardeners do not realize that powdered rooting hormones lose their strength with time. Store them in a refrigerator!

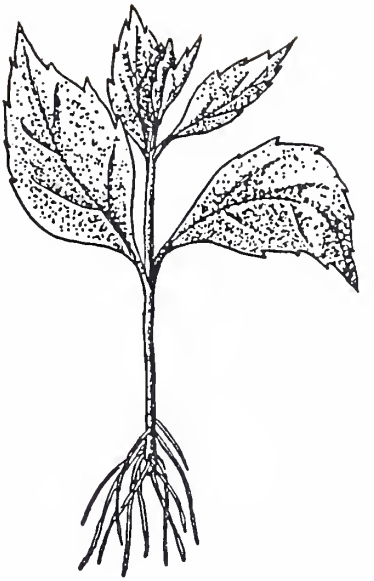
A fungicidal dip is made up of two teaspoons of Benomyl (Benlate) to one gallon of water. Five or ten cuttings, depending on size, can be gently swished around in the dip for a few moments, immersing the entire cutting in the solution. Then remove the cuttings and shake off the surplus liquid. Next, dip the tip of the cutting in the rooting powder, tapping off the surplus powder back into the dish.

Make holes for the cuttings with your dibble and insert the cuttings, firming them gently with your fingers. Then use your misting nozzle to thoroughly water in the flat and place it in the misting tunnel.

Set the timing of your intermittent mist at approximately four to five seconds every ten minutes. And watch carefully for a few days to see if the interval of mist is sufficient but not too frequent. The mist need not be on at night, unless your heating system dries the air excessively.

Check the cuttings daily for the first few weeks and remove any dead or dying leaves. If there are any signs of disease, clean the affected plants and spray them with Benlate.

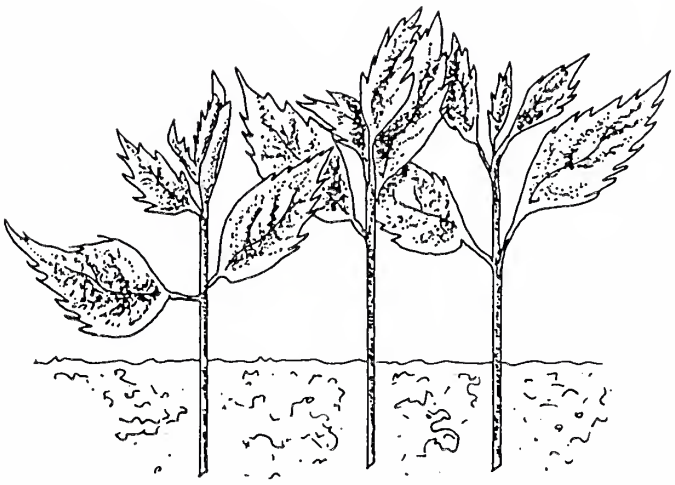
By the end of the fourth week, rooting should be achieved and the plants can be removed from the excessively moist conditions. Allow them to become accustomed to the drier air for a week or two. When the pot is well filled with roots and your small plant is growing vigorously, you are ready to pot it on into the next larger size pot.



Rooted cutting ready for transplanting.

There are other ways to propagate plants vegetatively. For example, dieffenbachias and dracaenas can be propagated by cutting their long, bare stems into segments. The stems are cut into two-and-one-half-inch-long pieces, and each piece must have an "eye" which shows as a little bump on the stem and ensures that the piece will sprout new growth. Place the pieces horizontally in a flat in the same basic peat perlite soil mix, taking care always to position the eye facing straight up. Keep the soil continually moist, and pot up the segment as soon as the eye begins to grow.

Ficus plants present another problem because the milky sap tends to harden and it prevents the plant from taking up water. The best method of propagation is



Cuttings are inserted into the medium to one-half of their length.

to air-layer this plant. In order to make a successful air-layer, it is essential to use a very sharp knife. You will also need a small stake (a quarter-inch by eight-inch dowel works admirably), some durable string and two handfuls of very wet sphagnum moss.

At a point at least eight inches from the top of the plant, cut or break off a leaf. Holding the eight-inch dowels as support against the stem, cut an upward slant behind the incision, but take care not to cut more than half way through, always holding the dowel rod as support. Keep the cut slightly ajar and place a little sphagnum in the opening to keep the wound open in order to prevent healing. Tie the dowel rod against the stem above and below the cut. Then place two handfuls of wet sphagnum as a ball around the wound. Finally, wrap the ball of sphagnum in one thickness of plastic. You will be able to see the roots through the plastic as they grow. When the layer is well-rooted, cut it off below the wound, pot it up and place it in a plastic tent for about a month until it is well established.

When you have mastered these methods of propagation you can be justifiably pleased with yourself. Brag a bit to your friends. But be prepared for the next batch of cuttings to fail completely!

DISEASE PROBLEMS IN HOME GREENHOUSES

ROBERT L. WICK

The Causes of Plant Disease

The causes of plant diseases are diverse and include pathogenic microorganisms as well as non-living factors such as air pollution, nutritional imbalances and other environmental stresses. For the purpose of this article, only diseases caused by fungi, bacteria, viruses and nematodes that are common to greenhouses will be covered. It should be noted that most microorganisms are not capable of causing plant diseases but rather perform important functions including contributing to soil formation, releasing nutrients from organic matter and suppressing plant pathogenic microorganisms.

Fungi are filamentous in structure and grow over or through the substrate that provides them with nutrition. Those

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Slug damage on a *Phalaenopsis* orchid flower. PHOTO BY CHARLES MARDEN FITCH

that have evolved into plant pathogens attack living plants, causing loss of food or aesthetic value. Fungi are extremely diverse in their ecology, growth habits, form and pathogenicity. Symptoms of disease also vary and include root rot, canker, leaf spot, abnormal growth and wilt.

Fungi that survive and reproduce in the soil are termed soil-borne. They are the principal cause of root and crown (lower stem) rot. Soil-borne fungi generally do not produce air-borne spores but are easily transported from contaminated soil to pathogen-free soil by tools, hose ends, water splash and hands. Fungi that cause disease of stems, foliage and flowers usually produce spores that are easily disseminated by air currents or insects.

Bacteria are very small microorganisms that occasionally cause important plant diseases in greenhouses. To put their size into perspective, approximately 600 bacteria lined up end-to-end would span one-sixteenth of an inch. With few exceptions, they cause disease by colonizing the internal tissues of plants, thereby interrupting normal growth and function. Like fungi they cause soft rots, cankers, leaf spots, abnormal growth and wilt. Plant pathogenic bacteria are also diverse in their ecological and pathological attributes. Spread of bacteria is usually by splashing irrigation water, contaminated tools and hands and by propagating from diseased plants.

Viruses are ultramicroscopic infectious particles. They can reproduce only in the presence of living host cells. Infected plants often do not show symptoms and may inadvertently introduce viruses into the greenhouse. The most familiar symptoms, mosaics, ringspots, line patterns and yellowing of the veins occur on the foliage. Tobacco mosaic virus (TMV) and tomato spotted wilt virus (TSWV) are common on greenhouse plants and can infect many different hosts. TMV is spread by physically handling diseased and then healthy plants. Cigarettes often harbor TMV so don't smoke when handling susceptible plants. TSWV is spread by thrips which are very small insects that are difficult to detect. Other insects such as aphids and leafhoppers can also spread viruses. Controlling plant-feeding insects in the greenhouse will help reduce the incidence of virus diseases.

Nematodes are small (one thirty-second to one-quarter-inch long) roundworms that are common inhabitants of field soil. Most nematodes are not parasitic on plants but prey on microorganisms, insects and other nematodes. Plant parasitic nematodes may attack the root system, stem or foliage depending on the species of nematode involved. Root-knot nematodes (*Melodogyne* spp.) cause galls of various sizes (usually one sixteenth to one-quarter inch) on the roots of a wide range of plants. The bulb and stem nematodes (*Dityleuchus* spp.) occur on hyacinth, narcissus, daffodil, tulip, and iris as well as other plants. Colonized bulbs may have necrotic areas and developing leaves have swellings and distorted growth. Foliar nematodes (*Aphelenchoides* spp.) attack the leaves and occur on bird's-nest fern, African violet, gloxinia, Rieger begonia, chrysanthemum, Boston fern, phlox, peperomia and India rubber plant. Symptoms caused by foliar nematodes may be easily mistaken for those caused by fungi or bacteria.

Plant Disease Control

Many diseases are not successfully controlled because the cause was not accurately determined. Thus, the first principle of disease control is to identify the cause of the problem. This may be done with the appropriate literature and experience but often technical help is

necessary. Contact your local Cooperative Extension office, plant disease clinic or garden center for assistance.

The use of resistant cultivars (varieties) is the ideal way to control diseases. Vegetable seed is usually designated as resistant to *Verticillium*, *Fusarium*, and root-knot nematode (or V, F, and N respectively). Resistance to other pathogens is available but limited. Check with your seed supplier or catalog for resistant cultivars.

Sanitation and cultural practices are among the most important ways to prevent and control plant diseases. Sanitation is a general term for the removal of diseased plant material and for the surface disinfection of tools and working surfaces. When disease occurs, affected plants or plant parts should be removed and taken away from the greenhouse. Do not discard plant material under the bench. Plant litter should be periodically removed from the floor. Used pots, flats and tools should be washed free of soil and treated with a 1:9 Clorox:water solution. Metal surfaces should be rinsed with water after treatment with Clorox to prevent rusting. Wooden structures and flats can be treated with copper naphthalate.

Sound cultural practices include the use of a pathogen-free growing medium with desirable physical qualities for the crop to be grown, proper regulation of water, fertilizer, temperature and humidity, and proper planting techniques. A continual effort must be made to avoid recontamination of the growing medium. Soil-less media (peat/perlite/vermiculite and other nonsoil mixtures) do not have to be treated before use. However, a preventative application of one or more fungicides is desirable for plants that are prone to damping-off or root rot. Soil from out-of-doors, whether used by itself or as an amendment in a soil-less medium, must be treated to eliminate soil-borne plant pathogens, insects and weeds. Hose nozzles which contact the floor or other soiled surfaces can effectively contaminate the growing medium with root rot pathogens. Provide a hook on the wall to hang up the hose.

Overwatering displaces oxygen in the soil resulting in an unhealthy root system and at the same time providing favorable conditions for root rot organisms such as the fungi *Pythium* and *Phytophthora*. Also, when soil remains cold and wet, ammonium, which is a fertilizer constituent, can build up to toxic levels. Over-fertilization can directly damage roots and also increase the severity of *Pythium* root rot. Have the growing medium tested periodically for ammonium and soluble salt levels.

The avoidance of high humidity and condensation of water on plants is essential for controlling *Botrytis* blight as well as other foliar diseases. High humidity is most prevalent during spring and fall. As the sun sets, temperatures fall and the relative humidity increases until the dew point is reached. Humid, wet conditions provide an ideal environment for spore germination and infection of plant tissues. To reduce humidity, evacuate the air from the greenhouse to allow the cool night air to come in. Raise the temperature several degrees and the relative humidity will decrease. Proper spacing of plants on benches, watering in the morning and circulating air with fans will also help reduce humidity within the plant canopy and thus help reduce diseases. An humidistat is a wise investment.

Fungicides can provide excellent control of some diseases but for others they may be ineffective, unavailable or illegal. When purchasing and using fungicides one must know which fungi are to be controlled, whether the fungicide is labeled for greenhouse use and if it is the appropriate formulation for the

application methods at hand. Do not rely on fungicides alone. A holistic approach to plant disease control is a much sounder approach.

Common Diseases in the Greenhouse

Damping-off

Damping-off is a disease of young seedlings caused by soil-borne fungi. Affected plants collapse and may have root rot, stem lesions at the soil surface or both. Flats of seedlings often damp-off in a circular pattern because fungi grow radially from the point of origin. Hot water from heat-baked pipes and hoses, excessively hot or cold temperatures and over-fertilization can mimic symptoms of damping-off. To control damping-off, it is essential to sow seeds in a pasteurized growing medium and to avoid overwatering and contamination with untreated soil. For particularly susceptible plants, use fungicide-treated seed or incorporate the appropriate fungicide into the medium at planting time.

Root Rot

Root rot is a destructive disease caused by several soil-borne fungi. Occasionally soft rot bacteria and plant pathogenic nematodes are involved. Healthy, actively growing feeder roots are white to light brown and firm. Diseased roots may have one or more of the following symptoms: water-soaked appearance, brown or black lesions, soft-rotting of the tissues and "rattailing," a condition where the outer cortex of the root sloughs off leaving a protruding resistant core (Fig. 1). Once above-ground symptoms of wilt occur, the disease has progressed too far and the plant cannot be saved. Since an unhealthy root system is not generally apparent until wilting occurs, every effort must be made to prevent root rot from occurring. Use a pathogen-free growing medium, avoid contamination and apply water and fertilizer as needed. Fungicides can be used to protect particularly susceptible or valuable plants but they will not cure existing disease. Contact your local Cooperative Extension floriculture specialist for specific pesticide recommendations.

Botrytis Blight

Botrytis blight is caused by the fungus *Botrytis cinerea* and is one of the most important diseases in greenhouses. It can attack flowers, foliage and stems of a wide variety of plants. A characteristic sign of Botrytis blight is the appearance of a grey mold on the affected tissue. Optimum conditions for Botrytis spores to germinate and infect plants occur when the air temperature is 45 to 60 degrees F, free moisture is present on plant surfaces for eight to 10 hours and humidity is 93 percent or greater. Disease development and spore production are favored by temperatures between 68 and 75 degrees F. Botrytis blight is prevalent during spring and fall because that is when favorable conditions in the greenhouse are most likely to occur. Thorough sanitation will help to control Botrytis blight. Remove all plant debris and dead flowers. Heat and ventilate during periods of high humidity, space plants adequately and provide air circulation. Several fungicides are available for controlling this disease.

Powdery Mildew

Powdery mildew occurs on many different greenhouse plants and is especially important on begonia and rose. The disease is evident on the upper surface of the foliage as a white, mealy appearing deposit. The symptoms are the result of a crop of spores, which, on some hosts, may be fairly sparse and thus overlooked. Since the fungus only colonizes the upper layer of leaf cells, severe damage to the plant does not usually occur. An

exception is begonia which can be severely damaged. The superficial growth habit of the fungus makes it one of the few diseases where application of the appropriate fungicide makes eradication possible.

Bacterial Diseases

As mentioned earlier, bacteria can cause many different diseases with symptoms similar to those caused by fungi. Soft rot of corms, bulbs, rhizomes and cuttings is often caused by bacteria. Soft rot is evident by a mushiness of the affected tissues and often a foul-smelling odor. The disease usually occurs under conditions of excessive soil moisture. Wounding of tissues by improper handling or by insects can also be important. Cyclamen corms that are buried too deeply are subject to decay. Soft rot cannot be controlled with pesticides. Avoid wounding and overwatering.

Several bacterial blights occur on begonia, chrysanthemum, geranium, poinsettia and bedding and foliage plants. In some cases bacterial diseases are seed-borne or present when the plants were purchased. Some plant pathogenic bacteria may be permanent residents within the greenhouse. Bacterial blights are spread by handling diseased plants, splashing irrigation water and by vegetative propagation from diseased plants. Depending on the bacterium involved, it may eventually destroy the plant or it may be of a minor consequence. If the plant material is valuable, a diagnosis by a specialist should be made. To control bacterial blights, buy seed from a reputable source, inspect plants for lesions before bringing them into the greenhouse, remove diseased plants from the greenhouse and avoid wetting the foliage during irrigation. Bacterial blight cannot be effectively managed with pesticides.

Mites infesting an orchid leaf.
PHOTO BY CHARLES MARDEN FITCH

Fusarium and Verticillium Wilt

Fusarium and *Verticillium* are soil-borne fungi that cause vascular wilts of plants. Symptoms include leaf yellowing and wilting, often on one side of the plant. A cut into the stem base will often reveal a discoloration of the vascular tissue. *Fusarium* and *Verticillium* are not often a problem in greenhouses; however, they can be a problem when unpasteurized field soil is used to grow susceptible plants. Occasionally plants are purchased that have vascular wilt disease and symptoms may not show up for several weeks. Discard affected plants. Use a pasteurized growing medium.

AN ALTERNATIVE METHOD TO CHEMICALS: BIOLOGICAL CONTROL

L. J. DUPRE

Too often, we equate pest control with killing insects, but the purpose of pest control is to prevent the damage that insects cause and to preserve plant or crop quality.

When establishing your own program, it is crucial to understand how pest problems become epidemic. Study the relationship of H (Host), E (Environment) and P (Pest). The area where all three overlap is I (Infestation). Think of all three as dynamic.

Small areas of overlap by all three denote minor infestations; total or near total overlap means an epidemic and possible plant death. Pest control means manipulating H, E and P to eliminate or reduce I so any damage is tolerable.

An actively growing, healthy plant generally resists diseases and is not attractive to insects. Plants under stress are vulnerable to insect infestations. Plant stress may be caused by too much or too little water, air, heat, light, soil pH or incorrect fertilization. In addition, a greenhouse provides ideal conditions for pest growth and development. In that artificial environment, insects, diseases and weeds can proliferate.

If an insect problem arises, it is important to begin by identifying the cause. Examine the infested plant carefully. You will find a hand lens helpful for finding mites, small insects and eggs. Once you have identified the problem, you are ready to seek solutions.

An excellent place to begin is by calling your local Cooperative Extension Office listed in the phone book under "County Gov't." Horticultural Agents or trained Master Gardener volunteers on the staff will help you identify problems and offer advice on corrective measures. The following general suggestions might help to control infestations.

By far the simplest method of pest control is to exclude outdoor pests by covering your greenhouse vents with a fine mesh screen while also keeping the door closed or using a screen door.

Insects are attracted to bright yellow objects. Sticky yellow lures are very effective for catching winged, soft-bodied insects. Paint thin pieces of plywood (6" x 12") bright yellow, coat thinly with Tanglefoot, Tacktrap, petroleum jelly or oil and hang or stake near your plants. Clean and recoat the lure as needed.

L.J. DUPRE *of Anacortes, WA retired after 30 years in the U.S. Navy and then turned his talents to gardening. He has been a master gardener for 13 years and writes a weekly column for a local newspaper.*

Similar traps are often sold at garden centers.

Brewed coffee or tea also controls certain insects. However, the brew must have caffeine — decaffeinated beverages won't work.

Rubbing alcohol applied with a cotton swab or spraved directly on the insect will help control mealybugs and scale insects.

Also effective are botanical preparations which include plant-derived poisons such as pyrethrins, rotenone, nicotine, ryania, sabadilla, and hellebore. They can be obtained locally or via mail order.

Both Safers, Inc., 60 William St., Wellesley, MA 02181 and Reuter Laboratories, Inc., 1400 Ford Building, Detroit, MI 48226 produce natural pesticides to control insects and diseases. Write to them for information and availability of their products.

Finely ground dusting sulfur is also relatively safe for controlling fungal diseases of plants.

Beneficial predatory or parasitic insects are available via mail order. Predators eat their prey while parasites lay their eggs in the eggs or bodies of other insects. Parasitic nematodes control damaging nematodes and insects which spend part of their life in the soil, although they do not harm earthworms. However, bear in mind that most beneficial insects are very specific about their host and so the pest to be controlled must be positively identified.

New botanicals are being tested and will shortly enter the supply pipeline. The neem tree (*Azadirachta indica*) of S.E. Asia has insecticidal properties and is being investigated. In addition, a broad spectrum insecticide derived from the American pawpaw tree has been patented. Beneficial molds to control disease problems have been isolated by USDA scientists.

Perhaps the most promising recent discovery is *Bacillus thuringiensis*. Almost 100 strains of this bacterial insecticide are being investigated as controls for a wide variety of insects including mites and beetles.

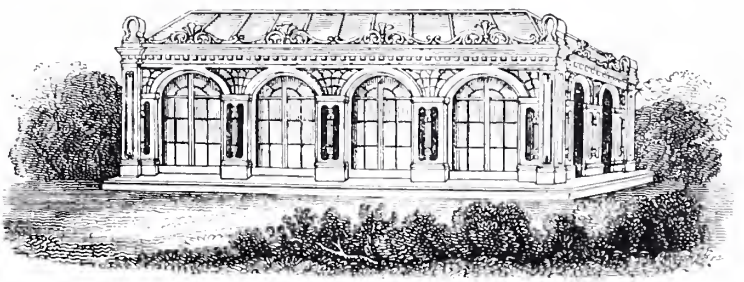
To keep abreast of developments in the field, look under "Biological Control" in the classified advertisement section of gardening magazines.

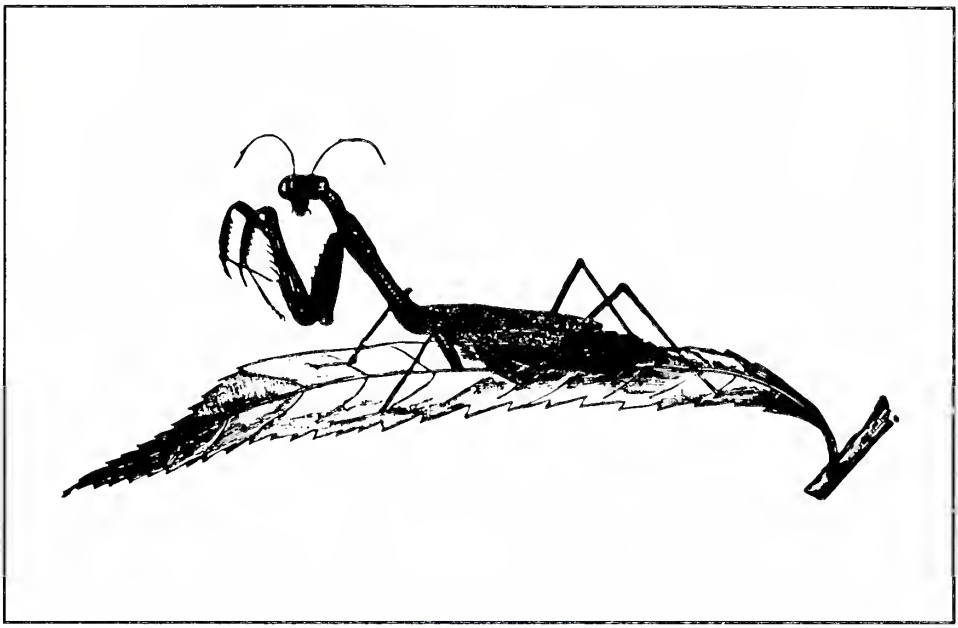
FOR FURTHER READING TRY:

Hussey, N.W. & Scopes, N.—editors. *Biological Pest Control, The Glasshouse Experience.* Ithaca, NY: Cornell University Press.

Cook, R. James and Baker, Kenneth F. *The Nature and Practice of Biological Control of Plant Pathogens.* American Phytopathological Society.

Ware, George W. *Complete Guide to Pest Control With and Without Chemicals.* Thomson Publications.





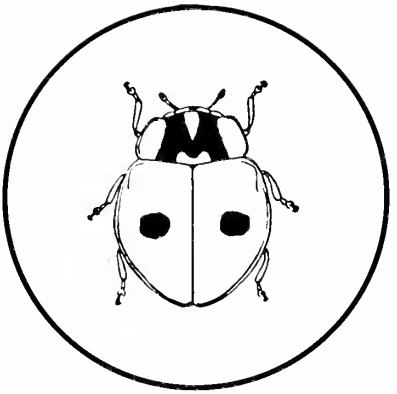
PUTTING BIOLOGICAL CONTROL INTO ACTION

ANNA EDEY

Insects have always been with us. Over 900,000 species are known to exist, and there may be twice that number not yet discovered. Approximately 99 percent of all insects are beneficial to mankind (insect-eaters, pollinators, aerators, composters, etc.). However, there are some insects that are considered to be harmful.

Since ancient times people have tried various methods of protection against insect infestations, but pests have remained a major problem all over the world. Solutions were sought in the form of chemical pesticides. However, we now

ANNA EDEY *of Martha's Vineyard, MA is the founder, designer and director of Solviva Winter Garden.*



Lady beetle

know the disastrous consequences of relying on "miracle cures." Many people are seeking more lasting solutions which lie in developing an understanding of ecological balance and coexistence.

That is what I set out to do when I started my 3000-square-foot solar greenhouse, the Solviva Winter Garden, in 1983. I wanted to demonstrate the feasibility of producing abundant quantities and varieties of the highest quality vegetables, herbs and edible flowers year-round. And I wanted to accomplish this without causing pollution and depleting precious resources in a climate where the temperature can hover around 0 degrees F for days, and the sun can remain hidden for weeks. In addition, I wanted to demonstrate that this could be a financially viable business.

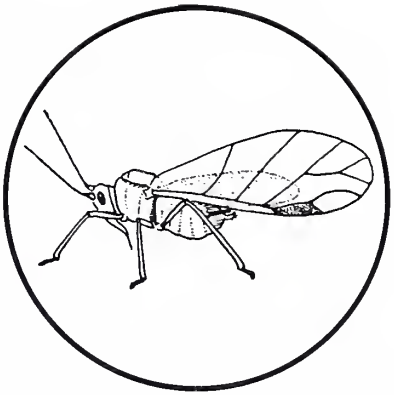
I am happy to report that after four years of continuously operating this solar greenhouse as an organic, high-yield year-round food garden, my hopes and dreams have not only been reached, but they have been greatly exceeded.

The solar operation is accomplished by combining sun's energy with animal heat. Sufficient heat is maintained throughout the winter by the storage of solar heat in about 4,000 gallons of water, combined with the body heat of chickens and angora rabbits living in enclosures within the well-insulated greenhouse. The animals also provide manure compost for soil enrichment. No back-up heat is required, even in the worst weather conditions. Natural ventilation cools the greenhouse in summer without the need of electricity. Photovoltaic panels and batteries power the circulating fans and working lights.

In the solar greenhouse, the insect management is unusually effective, easy and low-cost. Most importantly, it is absolutely non-toxic. Here is an eight-point program for success:

1) Introduce and maintain a variety of beneficial insects some of which come in from outside (such as syrphid flies, chalcid wasps, tachinid flies and braconid wasps); combined with insects that are brought into the greenhouse (such as *Aphidoletes aphidimyza* — aphid parasite, praying mantis, etc.); and some insects that I order from Rincon-Vitova, an insectary in Oak View, California (such as *Encarsia formosa* — greenhouse whitefly parasite, ladybugs, lacewings, predatory mites, etc.).

2) Grow nectar-producing flowers such as dill, parsley, fennel, cilantro, and alyssum from which the beneficial insects



Aphid

draw supplemental nourishment.

3) I maintain maximum plant health by good management of soil, air, temperature, sanitation and harvesting in order to resist insect attacks. A healthy plant has a strong cell structure and is harder for insects to penetrate than a weak one.

4) I grow many nasturtiums as host plants. Not only are nasturtiums beautiful, edible and nutritious, but they thrive in the darker areas of the greenhouse where few other plants would be productive. Of all the 200 or so varieties of plants in the greenhouse, the nasturtiums are most attractive to aphids, whiteflies, thrips, spider mites and leafminers. Therefore, they also furnish excellent habitats for the beneficial predatory and parasitic insects.

5) I monitor the situation. While watering or harvesting I constantly check the ratio of "good guys" to "bad guys." When necessary, I take action to keep the situation in the proper balance.

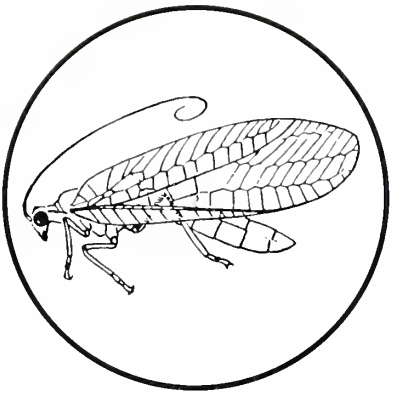
6) I leave many insect infested plants standing. This principle is the most difficult for visitors to understand. However, the weakened plants will attract harmful insects more than their healthy neighbors. If I pulled plants as soon as they got pest infested, I would interrupt the reproductive cycle of many of the parasitic insects. Infested plants are important insectaries.

7) I trust that harmony will prevail. This means that I do not intervene to eradicate the "bad guys," not even with insecticidal soap. If an insecticide is meant to kill or harm, it would certainly do the beneficials equal damage either directly or as they interact with the poisoned pests.

8) I do some hand-picking and trapping. Slugs and caterpillars can be a nuisance, and are the only critters I spend any time controlling. Slugs are best hand-picked at dawn or dusk, or trapped in small containers pressed into the soil and filled with beer, or collected from rotting pieces of wood under which they hide during the day.

However, after four years of trying to control caterpillars by hand-picking with unsatisfactory results, I recently decided to use Dipel (*Bacillus thuringiensis*). Not only did it work well, but it is reputedly non-toxic to anything but leaf-eating caterpillars.

Occasionally, there are rushes of aphids, spidermites or whiteflies. I hang on, allowing some of the lettuce to be overcome by aphids, watching in suspense as the beneficials increase in

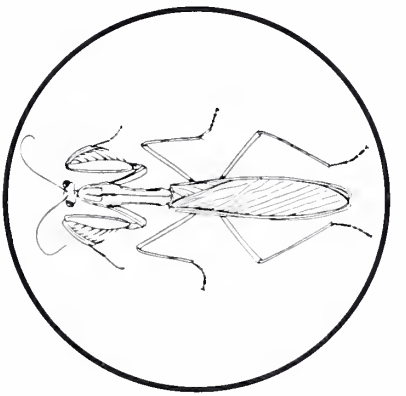


Lacewing

number. I go around with my magnifying lens and carefully distribute the beneficials to places in most need. As we harvest, we remove them and place them back in the greenhouse.

Research is rapidly progressing all over the world to find a biological control for every single pest, making it possible to achieve high food production without the use of any toxic chemicals. However, we are just beginning to discover the possibilities in biological control. There are some real challenges out there, not all of which are food related, such as wool moths, fleas, ticks and mosquitos.

Many people think of food crops as being riddled with pests which must be controlled with poisons. Therefore they assume that they cannot possibly grow foods in their home-attached greenhouses without endangering members of their household. The Solviva Winter Garden is living proof that it is possible to grow food safely in a greenhouse that is fully incorporated into a home.



Praying mantid

SUPPLIERS OF BENEFICIAL ORGANISMS

This list of suppliers in North America is excerpted from a list by Larry Bezark and Helen Yee of the State of California Biological Control Services Program, 3288 Meadowview Road, Sacramento, CA 95832.

The following companies list several beneficial organisms that may be helpful to greenhouse growers:

Bio Insect Control
710 S. Columbia
Plainview, TX 79072

Harmony Farm Supply
P.O. Box 451
Graton, CA 95444
free catalog

King's Natural Pest Control
224 Yost Avenue
Spring City, PA 19475
free literature

Mellinger's Nursery
2310 W. South Range Road
North Lima, OH 44452

Natural Pest Controls
8864 Little Creek Drive
Orangevale, CA 95662

Necessary Trading Company
P.O. Box 603
New Castle, VA 24127
charge for catalog

Organic Pest Control Naturally
P.O. Box 55267
Seattle, WA 98155
charge for catalog

Peaceful Valley Farm Supply
11173 Peaceful Valley Road
Nevada City, CA 95959
free catalog

Rincon-Vitova Insectaries, Inc.
P.O. Box 95
Oak View, CA 93022
free brochure

GREENHOUSE MAGAZINES AND SOURCES

MAGAZINES

Reprinted by permission of the Indoor Citrus Society from the Summer 1987 issue of Indoor Citrus and Rare Fruit Society newsletter.

Greenhouse Grower—published monthly by Meister Publishing Co, 37841 Euclid Ave., Willoughby, OH 44094.

Greenhouse Manager—published monthly by Branchsmith Publishing, 120 St. Louis Ave., Ft. Worth, TX 76104.

Hobby Greenhouse—published by the Hobby Greenhouse Association, 8 Glen Terrace, Bedford, MA 01730.

GREENHOUSE SOURCES:

Below are companies that sell greenhouses, compiled from lists from *Hobby Greenhouse Magazine, Greenhouse Manager Buyers Guide* and Barbara Barton's book *Gardening by Mail.*

HOBBY GREENHOUSE:

Eden—Northwest Eden Sales, Inc., 15103 NE 68th St., Redmond, WA 98052

English Cottage Greenhouse—Smith & Hawken, 25 Corte Madera, Mill Valley, CA 94941

Santa Barbara Redwood—Charley's Greenhouse Supplies, 1569 Memorial Highway, Mount Vernon, WA 98273

Hoop House Greenhouse—Fox Hill Farm, 20 Lawrence St., Rockville, CT 06066

Sun-Lite Greenhouse—Solar Components Corp., P.O. Box 237, Manchester, NH 03105

Northern Light Greenhouse—Gardener's Supply Co., 133 Elm St., Winooski, VT 05404

Halls Greenhouse—W. Atlee Burpee Co., Warminster, PA 18974

GREENHOUSE MANAGER:
(M manufacturer, W wholesaler, D distributor.)

A&P Ag Structures (M), 11266 Ave. 264, Visalia, CA 93277.

ADJ Horti-Projects Inc.(M), Box 3004, Langley BC, Canada V3A 4R3.

Agro Projects (M), 7114 Pomelo Dr. I, Canoga Park, CA 91307.

Aluminum Greenhouses, Inc. (M), Box 11087, Cleveland, OH 44111.

Anderson Orchids, 2059 Lee Rd., Smyrna, GA 30080.

Atlas Greenhouses, 117 Wakefield, Hampton, CT 06517.

B.F.G. Supply Co. (W), 14500 Kinsman Rd., Burton, OH 44021.

Ball Seed Co., Box 335, W. Chicago, IL 60185.

Beck Greenhouse Co. (M), Box 650, Auburn, AL 36830.

Carson & Associates, Cliff, 204 Forest Dr., Greenwood, SC 29646.

Clover Greenhouses By Elliott Inc. (M.W.), Box 789, Smyrna, TN 37085.

D.A.C.E. Inc. (M), Box 475, Port Jefferson, NY 11776.

DeCloet Ltd. (M), Box 145, Tillsonburg, ON, Canada N4G 4H3.

Double A Truss Mfg. Co. Inc. (M.W.D), 320 Wetmore, Manteca, CA 95336.

Geiger Corp. (W.D), Rt. 63, Box 285, Harleysville, PA 19438.

Growers Intl. Inc. (W), Box 10, Schulenburg, TX 78956-0010.

Harnois Industries, (M.W) 1044 Main. St. Thomas of Joliette, PQ Canada, JOK 3LO.

Hydro-Gardens Inc., Box 9707, Colorado Springs, CO 80932.

Landreth Nursery Co., 1000 Far Shores, Hot Springs, AR 71913.

Lord & Burnham (M), Box 255, Irvington, NY 10533.

Ludy Greenhouse Mfg. Corp., Box 141, New Madison, OH 45346.

McAllister Co. Inc. (M.D.), Box 6667, Burbank, CA 91510.

Nexus Greenhouse Systems Corp. (M), 10983 Leroy Dr., Northglenn, CO 80233.

Northern Grower Systems Inc. (M), 1550 E. Shore Dr., St. Paul, MN 55106.

Pacific Coast Greenhouse Mfg. Co., 83600 Industrial Ave., Cotate, CA 94928.

Prins Greenhouses, 201 Maison St., Elmhurst, IL 60126.

Rough Bros. Inc. (M), Box 16010, Cincinnati, OH 45216.

Serac Ltd. (M), Box 2186, Davis, CA 95617.

Smith Inc. (M), Drawer X, Box 272, Red Bank, NJ 07701.

Stuppy, Inc., Box 12456, N. Kansas City, MO 64116.

V&V Noordland, Inc., Box 739, Medford, NY 11763.

VEBO Ltd. (M), 196 Belleview Ave., Center Moriches, NY 11934.

Van Wingerden Greenhouse Co., (M), 4078 Haywood Rd., Horse Shoe, NC 28742.

Vary Industries (M), Box 248, Lewiston, NY 14092-0248.

Winandy Greenhouse Co. Inc., 2211 Peacock Rd., Richmond, IN 47374.

Zethof Greenhouse Services Inc., Box 331, Wellington, OH 44090

(Check *Greenhouse Manager's* **All-Industry Buyer's Guide Product Directory**, Spring 1987, for additional manufacturers.)

Gardening by Mail:

Gothic Arch Greenhouses, P.O. Box 1564, Mobile, AL 36633-1564.

House of Redwood, 2910 E. Blue Star Ave., Anaheim, CA 92806.

Santa Barbara Greenhouses, 1115 Ave. Acaso #J, Camarillo, CA 93010.

McGregor Greenhouses, 1195 Thompson Ave., Santa Cruz, CA 95062.

Machin Designs (USA) Inc., P.O. Box 167, Rowayton, CT 06853.

Bloomin' Greenhouse, Inc. 7591 Wilson Blvd., Jacksonville, FL 32210-3535.

Suncraft, Inc., 414 South Street, Elmhurst, IL 60126.

Janco Greenhouses, 9390 Davis Avenue, Laurel, MD 20707-1993.

Turner Greenhouses, P.O. Box 1260, Goldsboro, NC 27530-1260.

Sun System Greenhouses, 60-D Vanderbilt Motor Pkwy., Commack, NY 11725.

Four Seasons Greenhouses, 425 Smith Street, Farmingdale, NY 11735.

Vegetable Factory, Inc., 71 Vanderbilt Avenue, New York, NY 10169.

Aluminum Greenhouses, Inc., P.O. Box 11087, Cleveland, OH 44111-2140.

Cropking Greenhouses, P.O. Box 310, Medina, OH 44258.

Sturdi-Built Mfg. Co., 11304 S.W. Boones Ferry Rd., Portland, OR 97219.

Texas Greenhouse Co., 2723 St. Louis Ave., Ft. Worth, TX 76110.

Sunglo Solar Greenhouses, 4441 26th Ave. West, Seattle, WA 98199.

Practical handbooks to share the Brooklyn Botanic Garden's 76 years of excellence in horticulture, education and community service.

Ornamental Grasses

Plants & Gardens

Brooklyn Botanic Garden Record

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BROOKLYN BOTANIC GARDEN RECORD

Ornamental Grasses

1988

Brooklyn Botanic Garden

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PLANTS & GARDENS
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Ornamental Grasses

Vol. 44 Fall 1988 No. 3

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Pennisetum alopecuroides *combined with begonias at Longwood Gardens.*
Cover photograph by Elvin McDonald

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foreword

Peter Loewer

The grasses, *Gramineae* to the botanist, represent the most important single plant family on earth, since they alone produce all the cereal grains that have sustained humanity throughout recorded history. This handbook deals with a very small segment of the over 10,000 cataloged species: those grown for ornament in home and garden. Popular in Europe and Asia for years, the ornamental grasses have been largely overlooked by the American gardener in favor of plants that are thought to be showier in form and color. If the American public knows the ornamental grasses at all, it's as dried accompaniment to winter bouquets.

In Japan and China, where gardens have been appreciated for thousands of years, it is no longer important how many plant varieties one can grow, but rather how many facets one can see in a single plant. Theirs is a culture that finds restful contemplation in gardens made entirely of mosses, grasses or stones. And grasses truly lend themselves to such an examination.

Today, our culture is a mobile one, and because of economic demands the typical family no longer settles in one place for its entire existence, and few people bother with the less flamboyant or slower growing members of the plant world. Instead, we demand the fast and the blatant bloom, and thus the graceful grasses are relegated to the lawn for cutting and the gift shops of colonial Williamsburg, where as dried flowers, they remind us of our agricultural past.

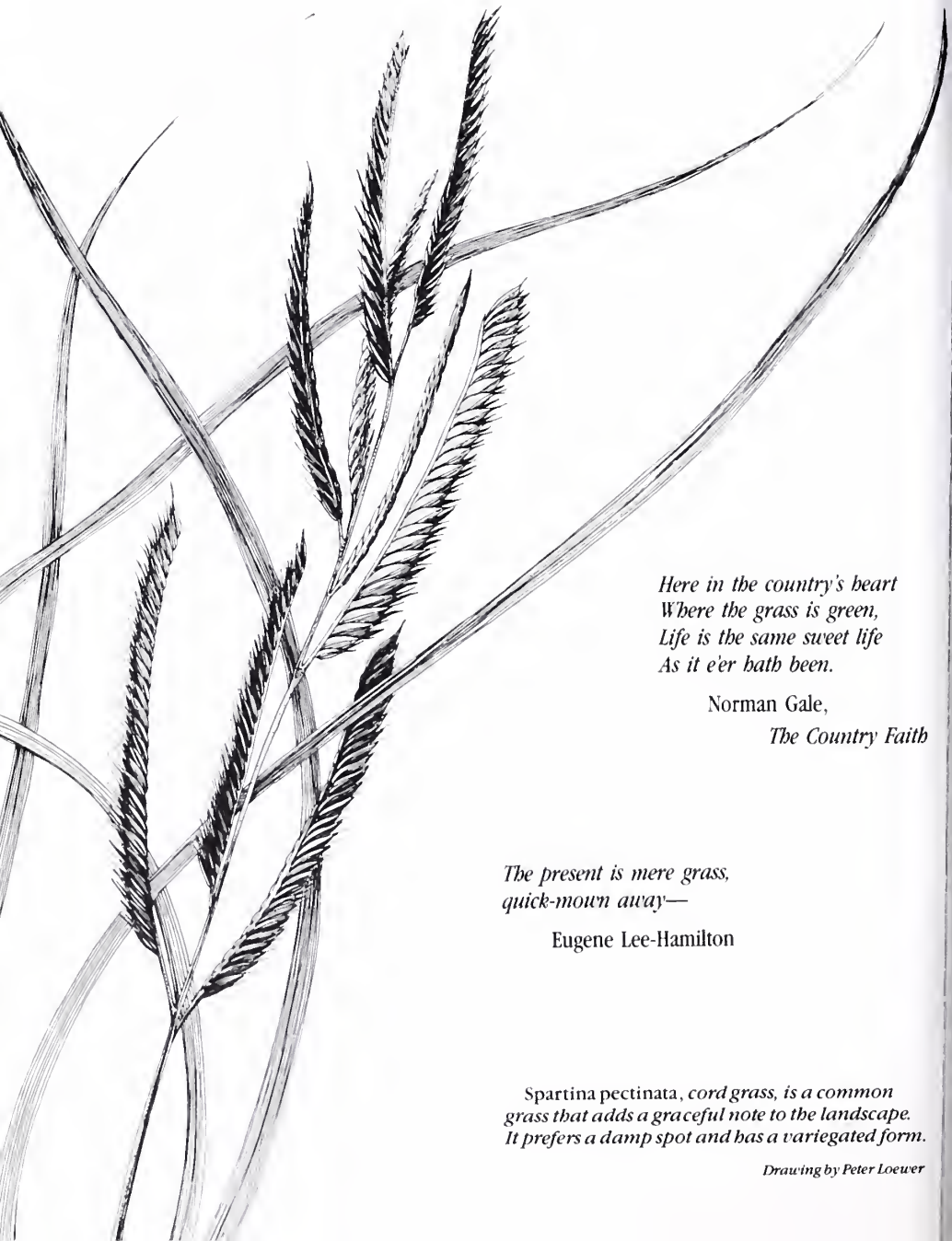
At this point I'm reminded of two memories: The first was my initial glimpse of a mature clump of zebra grass in Paula Roos's twenty-year-old garden in Honesdale, Pennsylvania, and the majesty it commanded; the second is the following story of two American visitors touring an English estate:

"Goodness, me," said one as they trod the palatial lawn, "this grass is magnificent," and turning to the head gardener, asked: "How do you get a beautiful lawn like this?"

"Well, ma'am," he said, "first you roll it for three hundred years."

Miscanthus sinensis *'Zebrinus' is striped horizontally which creates an unusual effect. It prefers wet soil, stands shoulder high and is topped in autumn and winter with feathery plumes.*

A Garden of Grasses



Here in the country's heart
Where the grass is green,
Life is the same sweet life
As it e'er hath been.

Norman Gale,
The Country Faith

The present is mere grass,
quick-mown away—

Eugene Lee-Hamilton

Spartina pectinata, *cord grass, is a common grass that adds a graceful note to the landscape. It prefers a damp spot and has a variegated form.*

Drawing by Peter Loewer

Peter Loewer

I've been growing ornamental grasses in the garden for over eight years. By the end of August, eulalia grass is often over 10 feet tall, reed grass reaching to 15, Japanese blood grass is turning deep red, goldentop shimmers with silken gilt, blue fescue forms eight-inch clumps of steely blue, and spike rush is one inch tall. They are all beautiful.

Unfortunately at the same time that the garden is a graceful jumble of abstract lines, the lawn is a scraggly two inches higher than it should be and badly needs a trim.

It's difficult to realize that they all belong to the same family, the *Gramineae,* a family that probably represents the single most important group of plants in the world.

For rice, wheat, oats, corn, bamboo, barley, rye, sorghum and sugar are all related. In their seeds and foliage are stored the starches, sugars and vitamins needed to keep humanity alive and healthy.

And it's also the family that contains crabgrass and 274 other common names for 274 individual species that have been in commerce —or backyards—at one time or another.

Annual ornamental grasses are usually grown for their seed panicles—flowers are minute and hardly noticeable—many of which dry beautifully for winter bouquets. Their leaves are usually not too showy.

Perennial grasses have magnificent and varied foliage in all shades of green, blue, and variegations of cream, white, gold, or a host of tans, in addition to notable seed heads.

Sizes run the gamut from tiny to huge, they belong in every garden and if you have the room, they make an impressive garden all their own.

Included in this garden are a few plants that are usually thought of as grasses but really belong to closely allied but more primitive families: the sedges and the rushes.

A Garden of Perennial Grasses

This garden of grasses is planned for a plot measuring 10 by 20 feet. It features 15 species or cultivars of the perennial grasses (including two tropical varieties), one bamboo, and one sedge, for a total of 17 different plants. You might think this is a small number of plants for such a large piece of ground? It isn't! The grasses take a lot of room.

If you want to get some of the feeling of walking through a jungle, plant a thicket of eulalia grass or ravenna grass. By summer's end you will be amazed at the size of these grasses. Three years of active growth are needed before these plants approach their ultimate size.

Ornamental grasses grow in average garden soil. Remove the turf, then turn the earth to a depth of one foot. Add a mix of clean garden soil and some composted manure to make up for the lost earth. Plants do best (except for sea oats) in full sun.

The only real chore in dealing with grasses is the annual pruning of the larger types in early spring. Cut the dead stems and leaves to within six inches of the ground before new growth begins.

The larger clump-forming grasses grow from the inside out so plants die out in the center after a few years. Then divide the clumps with an ax, and pass on extra plants to other gardeners. These plants are not fragile.

Reprinted from Gardens by Design, *copyright 1986, Peter Loewer. Permission granted by Rodale Press, Inc., Emmaus, PA. 18049.*

Peter Loewer, guest editor of this handbook, is a botanical artist and scientific illustrator who writes magazine articles, and writes and illustrates his own books on gardening. His most recent is The Annual Garden *and he is now at work on a book entitled* American Gardens.

Plants for the Grass Garden

In the following descriptions, the height given is that of the plant in bloom, when the plumes usually stand above the leaves. Except for the tropicals, they are all hardy in Zone 5. Those that can live in Zone 4 are so marked. The first measurement is the height and the second the spread of the plant, in inches.

At Wave Hill, a beautiful formal garden in the Bronx, New York, there is a specimen of ravenna grass planted in solid rock. Blasting two and one-half feet of rock was required to make the hole. The effort was worthwhile: the grass, both in leaf and in bloom, is spectacular! That grass is the center of the planting with others grouped—according to height—around it. The plan also includes a short path of stone that would be an ideal place for a sundial or a spot to summer out the tropical grasses.

The first grass is a bamboo *(Arundinaria viridistriata),* that is hardy with protection in Zone 5, where it is not invasive. Farther south care must be taken in planting to prevent unwanted spread. This bamboo is a true beauty: the leaves have a velvety look when new and are a rich combination of gold and green that glows in the distance. The stems reach a height of two and one-half feet. It prefers partial shade and I find it does best when grown in a 12-inch pot.

Japanese sedge grass *(Carex morrowii* var. *expallida),* 18 by 8 inches, is hardy in Zone 5 but cover with evergreen branches or other loose mulch for the winter. Provide shade from the noonday sun in summer. The gracefully arched leaves are striped with creamy white and green. Flowers resemble camel's-hair brushes dipped in yellow powder and appear in spring.

Northern sea oats *(Chasmanthium latifolium),* 36 by 24 inches, will also tolerate some shade. It is still listed as *Uniola latifolia* in many catalogs. This is a beautiful plant with flat panicles of drooping flowers that are green at first but turn a golden brown after a severe frost. If started from seed, sea oats will not grow with gusto until the second year.

Lemon grass *(Cymbopogon citratus),* 36 by 12 inches, is only hardy in Zone 10, but can be grown in a pot in northern climates. It will rarely exceed three feet when grown indoors but can top six feet in the tropics. The flower, if it blooms, is nondescript, but the plant is very attractive with its arching leaves of light green. Lemon grass is the commercial source of lemon oil, and a crushed leaf sends forth a wonderful aroma. Plant in light soil with plenty of sand for good drainage. Take indoors for winter in cold areas.

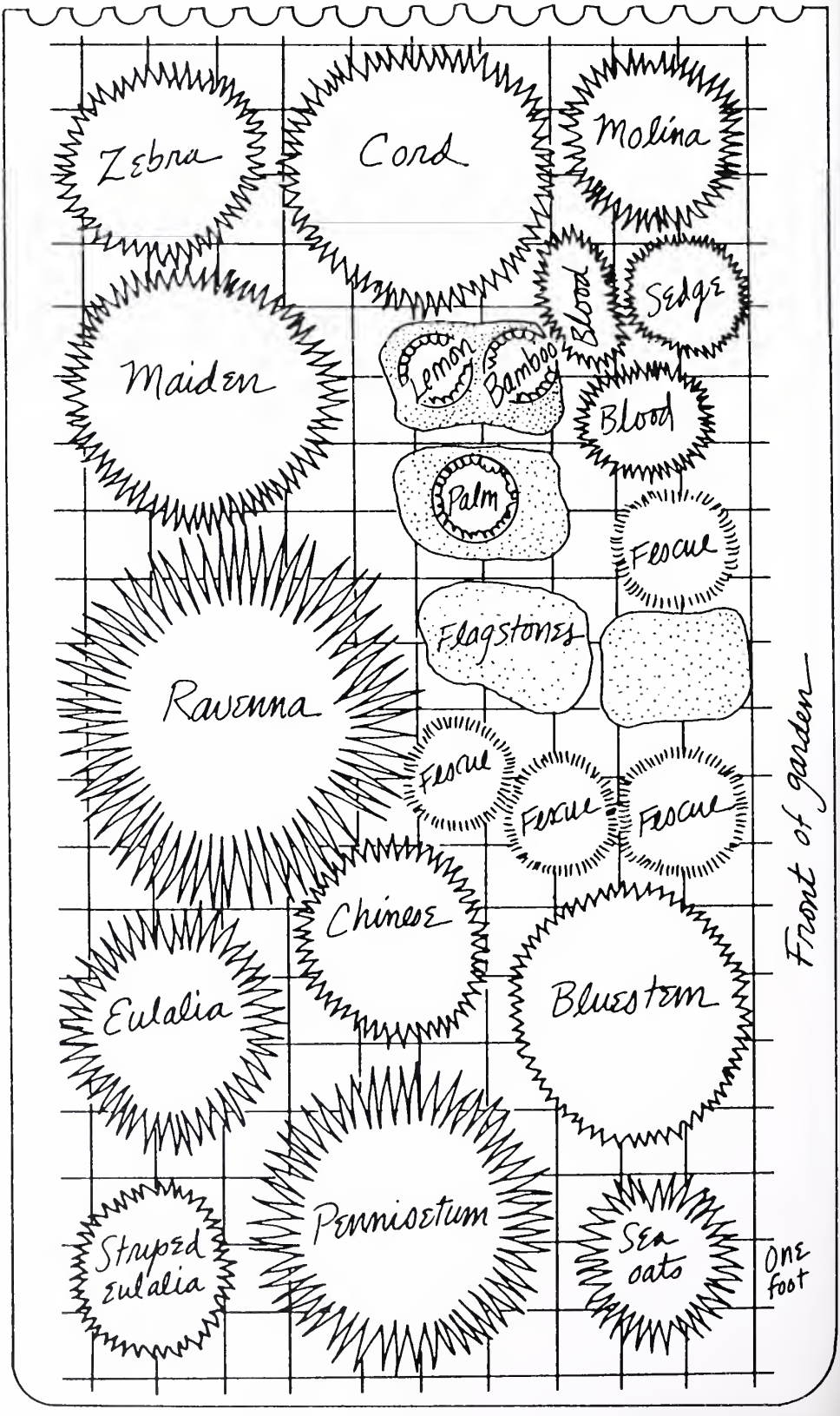
Ravenna grass *(Erianthus ravennae),* 10 to 11 by 5 feet, is the tallest of grasses so some thought should go into its placement. The leaves form a fountain of green that change to a rich brown in early autumn. Then silvery-beige plumes appear. Add composted manure to the soil before planting.

Blue fescue *(Festuca ovina* var. *glauca),* 18 by 10 inches, is hardy in Zone 4. It is a variety of sheeps' fescue grass and has a bluish bloom, which is actually a powder that covers the leaf-blade surfaces and will easily rub off. The name is derived from the Celtic word *fest,* meaning pasture. Plant these grasses in clusters and use them to fill up any vacant spots. The clumps are easily divided when they become too large. Flowers are rather small; the color and shape of the leaves is the chief reason for cultivation.

Japanese blood grass *(Imperata cylindrica rubra),* 18 by 12 inches, is hardy to Zone 5 with winter protection from freezing winds. I solved the problem of exposure by placing the plants in front of a low wall. In the plan an uneven space with a three-foot diameter is set aside for this grass. The reason for cultivating this grass is the color: rich, blood-red that starts about midway on the grass blade and reaches to the tip. Japanese blood grass is fairly new to this country. It has never flowered for me: I think the season just isn't long enough.

Chinese silver grass *(Miscanthus floridulis),* 8 by 3 feet, sits next to eulalia grass in the plan

Erianthus ravennae, *ravenna grass, is the tallest of grasses (10 to 11 feet tall by 5 feet wide) so must be placed with care. The leaves form a fountain of green in spring and summer changing to rich brown in autumn when silvery-beige plumes appear.*



Drawing by Peter Loewer

as it's the shorter of the two. They are alike, except for stature.

Eulalia grass (M. *sinensis*), 10 by 3 feet, is a genus of ornamental grasses extensively cultivated throughout the world. These grasses grow very tall and produce magnificent plumes of silvery spikelets with a purple sheen and are much like the feathers carried by Egyptian slaves to fan Cleopatra. As the summer progresses, the bottom leaves die back, and by tearing them off the handsome stems are revealed. These stems become very dark and hard with age and exposure to weather. After the growing season is over, the stems can be cut and polished. In ancient Japan they were used to make many implements: brush handles, kitchen utensils, and tools for print making. If your growing season is less than 90 days, eulalia grass may not flower, but it's worth growing for the leaves alone.

Maiden grass (*M. sinensis* 'Gracillimus'), six by four feet, is aptly named—both its common and cultivar names—since the plant reflects the charm of a graceful maiden. Leaves are light green, with a white mid-rib, long, narrow and lightly curved at the tips.

Zebra grass (*M. sinensis* 'Zebrinus'), six by three feet, is another favorite of mine: individual leaves are dashed with horizontal bands of a light golden brown. A clump can become massive over many years and resembles a sparkling fountain. Zebra grass, like others of the *Miscanthus* tribe, prefers damp soil so it's excellent for the poolside.

Striped eulalia grass (*M. sinensis* 'Variegatus'), five by three feet, is the variegated form and its leaves are heavily striped with white.

Fountain grass (*Pennisetum alopecuroides*), three by four and one-half feet, has a very wide

A plan for a garden of grasses using those described in this article. This garden resembles that of the guest editor—photographs of which appear in other places in this handbook.

Miscanthus sinensis *'Zebrinus', zebra grass, has individual leaves dashed with horizontal bands of light golden brown. A clump can become massive, resembling a sparkling fountain.*

Photo by Elvin McDonald

spread—its leaves and flowering stems arch toward the ground. The blossoms are especially beautiful when covered with dew and lit by the morning sun. Fountain grass is effective when placed next to a planting of little bluestem, for the reddish stems of the second plant echo the russet tones of the first. Leave enough room for the plant's spread.

Little bluestem *(Schizachyrium scoparium),* four by four feet, is still listed in many catalogs as *Andropogon scoparius.* It's the state grass of Nebraska. The flowering stems turn a golden reddish-brown in the fall sparked with tiny white tufted blossoms along their edge.

Palm grass *(Setaria palmifolia)* is a slender tropical grass that reaches six feet in a warm climate. The plaited leaves are two feet long and three inches wide, and a deep emerald green. The plants grow well in containers but require full sun outdoors in summer to thrive. I grow palm grass in a 14-inch pot.

Cord grass *(Spartina pectinata* var. *aurea variegata),* five by four feet, has many common names: bull grass, tall marsh grass, slough grass (*slough* is an old Anglo-Saxon word meaning a wet or marshy place), freshwater cord grass, and upland creek grass. American pioneers used this grass to thatch roofs and protect haystacks against the weather. This variegated form of the common grass is quite graceful in the landscape, with bending leaves striped with light tan. As its many names suggest, cord grass does well in a damp spot.

Purple moor grass

The *Dictionary of Gardening* compiled by the Royal Horticultural Society (of England) has the following entry for purple moor grass:

Molina (in honor of Juan Ignacio Molina, 1740-1829, writer on the natural history of Chile). Fam. *Gramineae.* A genus of perhaps two species, one spread over Europe, Asia Minor, and N. Asia, the other Japanese. Perennial densely tufted grass with slender leaves. . . A grass of bleak, wet moorlands, the variegated form of which is a good bedding plant; propagated by division.

"Bleak, wet moorlands," and "a good bedding plant," what telling phrases and so English, such understatement for a grass that should be in every garden.

And especially interesting since its one of the few grasses where actual outdoor observations have documented early stages of germination.

In 1915, T.A. Jefferies, wrote the following: *On the moors about Huddersfield . . . little peat hollows, sometimes only about two square feet in area, are common; these become pools in wet weather, but are robbed of their surface water by a few days' drought. Bright sunshine and strong wind playing on the unprotected surface of such a hollow, cause the formation of a network of cracks. Into these the seeds of* Molina *are blown, and are sheltered there from the wind. When the water has disappeared in the early summer, lines of crowded seedlings appear, marking out the meshwork of last season's cracks like miniature green hedgerows.*

Later, Jefferies points out that the root system of *Molina* is particularly notable for the firmness of its roots, making it difficult to pull up from the ground. It is also noted that the swollen nodes at the base of the plant were often used as pipecleaners and toothpicks while the dried stems went into local broom manufacture.

While I cannot testify to the germination I can note its tenacious hold upon the soil, and also to its beauty of the variegated form.

We have had it in the garden since 1978. Each year the fountain of rather rigid leaves, each banded with white stripes and gently curving towards the ground, becomes a little larger and more impressive. The panicles occur atop curving stems and reach three feet in height and are striped like the leaves but tinged with violet and greenish highlights.

Unlike most grasses, *Molina* will tolerate some shade, prefers an acid soil and will put up with some dampness. And that fibrous and tough root system, makes it an excellent plant for banks, and steep hillsides.

If forced to choose, choose this plant.

Miscanthus sinensis *'Gracillimus' is a lovely grass with graceful light green leaves with a white mid-rib—long, narrow and lightly colored at the tips.*

Establishing a Prairie Grass Garden

Margaret Stock

The American prairies were originally flat, grass-covered and treeless plains that stretched from western Ohio, through Indiana, Illinois, and Iowa, to the Great Plains. Because of the richness of the soil they are not prime producers of crops. —P.L.

When you plant a mini-prairie in your backyard, you will be planting a bit of history. The early pioneers migrated across the plains in their prairie schooners—wagons covered by a canopy of white canvas—and found the vast grasslands, abundant with wildflowers, ready to be broken by the farmer's plow. The farmers discovered rich, fertile soil, that today produces the food that feeds America.

We can't bring back the prairie as it was centuries ago, but you can plant an area in your own backyard that will resemble one. Enjoy the wildflowers—blanketflower, cornflower, black-eyed Susan, upright coneflower, purple prairie clover, partridge pea, dame's rocket, thickspike, gayfeather and purple coneflower—as they bloom from spring into fall. And of course the grasses. Some of the flowers are annuals and will bloom the first year while others are perennial and may not bloom until the second spring or summer. The grasses for a prairie garden are all perennials.

The grasses take a bit of patience. Little bluestem *(Schizachyrium scoparium),* sideoats grama *(Bouteloua curtipendula),* Indian grass *(Sorghastum nutans),* and blue grama *(Bouteloua gracilis),* are all busy putting down roots for the first year, roots that grow so

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Margaret Stock is a member of the Stock family, owners and operators of Stock Seed Farms, Inc., in Murdock, Nebraska. They maintain 700 acres of grasses and 25 acres of wildflowers for seed production and grow 36 varieties of grasses and wildflowers.

deeply that the plants were able to withstand the prairie fires that would rage across the landscape.

Plant the seed in the spring through the early summer. Or plant late enough in the fall so that the seeds will not germinate until the following spring. Remember that prairie plants are not adapted to shade so pick a site that receives full to partial sun and is well drained.

Prepare a seedbed that is free of grass and weeds. The clean seedbed should be firm, not fluffy. Broadcast seed evenly and rake in lightly to a maximum depth of one-eighth inch. Don't worry if some seed shows on the surface of the soil.

The seeds need plenty of water to germinate. Keep the seedbed moist for four to six weeks. Reduce the frequency of watering as the plants become established. After they are entrenched, little care will be needed. Be sure to water when drought conditions exist.

Big bluestem *(Andropogon gerardii)* grows between four and five feet tall and is often called the "king" of native grasses. After frost, this sod-forming grass turns a light reddish-purple.

Blue grama *(Bouteloua gracilis)* grows three to six inches high. It is a long-lived grass that has white-purplish spikelets or flags on each stem.

Indian grass *(Sorghastrum nutans)* is five to eight feet tall, and waves its golden, plumelike head in September making it one of the most beautiful of native grasses.

Reed canary grass *(Phalaris arundinacea)* grows two to four feet tall and is especially suited for wetlands and waterside plantings.

Sand love grass *(Eragrostis trichodes)* only reaches about one foot in height but has lovely purplish, feathery seed heads, growing best on sandy soil.

Switchgrass *(Panicum virgatum)* grows four to five feet high, has beautiful seed heads, and turns a lovely orange-yellow color in winter.

Native Ornamental Grasses

Mrs. Mary Agnes Chase was an Honorary Fellow of the Smithsonian Institution and a dean of American agrostologists. She was the author of *First Book of Grasses* published by the Smithsonian and an accomplished botanical illustrator. The following article was taken from *The National Horticultural Magazine* for January, 1928.

Agnes Chase

When one speaks of ornamental grasses a mental picture arises of a great clump of eulalia *(Miscanthus sinensis)* like a spouting volcano in the middle of a lawn, or of rather unsightly tussocks of ribbon grass *(Phalaris arundinacea picta)*, or at best of fountain grass *(P. setaceum)* with its faintly rosy panicles, surrounding circular beds of cannas in city parks. Giant reed grass *(Arundo donax)* and pampas grass *(C. selloana)* are also commonly grown in great clumps in our parks. None of these, except *P. setaceum*, approaches in grace and beauty a large number of our native grasses.

For a bold clump in the open, our perennial Indian grass *(S. avenaceum)* with its stately stems four to five feet high would be far more handsome than eulalia. It is not so coarse; the clumps are not a dense mass but more open and graceful. The long tapering upright golden-bronze panicles appear in early September and last about a month, turning russet toward maturity. This grass is widespread, from the northern Atlantic states to the foothills of the Rockies. In a garden or park it would be effective toward the back of a perennial border or at the margin of shrubbery, at a corner or sharp curve. This grass does not make rapid growth early in the season, being only about three feet high in early August,

Agnes Chase became interested in botany at an early age and while in Chicago, worked at night as a proofreader on the Inter-Ocean *newspaper and botanized during the day. In 1936, she became the senior botanist in charge of all systematic agrostology at the United States Department of Agriculture.*

Sorghastrum avenaceum, *Indian grass, has stately stems sometimes reaching to five feet in height. The clumps are open and graceful. The golden panicles appear in early September.*

Drawing by Peter Loewer

hence is better adapted to borders or corners than to use in open lawns.

Another native species for borders in such places as ribbon grass is used is wild rye *(Elymus canadensis)*. This is also widespread and hardy from the Atlantic nearly to the Rockies. The stems stand about three feet high and from July to September bear nodding heads five or six inches long, with long slender curving bristles. The leaves are about half-an-inch long and graceful.

Hystrix patula, *bottlebrush grass, has gray stems, spreading leaves and long-awned spikelets. The drawing on the opposite page illustrates the size of this grass.*

Purpletop *(Tridia flava)* with very smooth foliage and handsome large drooping purple panicles, blooming during August and September, is found from southern New England to Missouri and southward. It can be used in a sterile bit of soil where other plants do not thrive. It is particularly charming back of Michaelmas daisies and our other native asters.

The most beautiful of our native grasses is broadleaf uniola *(Chasmanthium latifolium).* It grows in low woods from Pennsylvania to eastern Kansas and southward, but is not nearly so common as the species mentioned above. Though a woodland grass it flourishes in open sunlight. Some ten years ago I brought a clump from near the Potomac and set it in my garden. It has thrived without any care at all and has furnished clumps for neighbors and friends. Its graceful stems, three to four feet high, broad spreading leaves, and drooping panicles of large very flat spikelets, are charming in a perennial border or at the margin of shrubbery. The plant is also effective in shaded ground under trees and tall shrubs. The panicles appear in early August and last fully two months. A single stem with its graceful panicle or a few in a slender vase, or a greater number arranged in a standard in a broad flat bowl, are very decorative in the house. (Editor's note: these are the only ornamental grasses whose seed heads retain their green color when dried.)

For those fortunate enough to have wooded slopes or a bit of rich woods there are several elegant native grasses besides uniola. In the northern states *Milium effusum,* with tall slender pale stems, broad leaves, and graceful delicate panicles of small whitish spikelets, would add beauty to shaded ground.

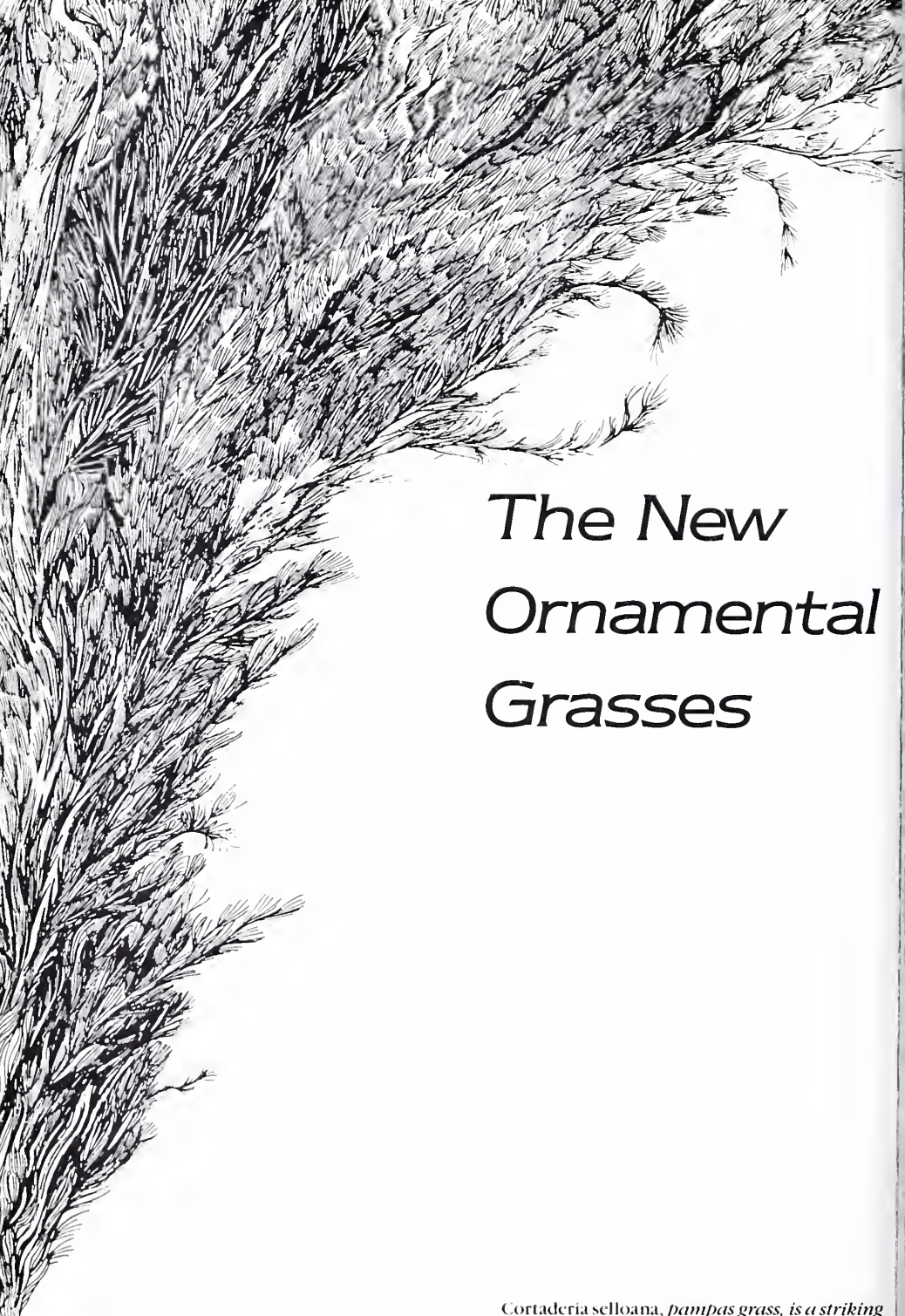
Our native woodland brome grasses *(B. canadensis* and close relatives) are found throughout the northern states and southward. They grow in small tufts, the slender stems four to six feet tall, with graceful foliage and drooping panicles of long spikelets.

Woodreed *(Cinna arundinacea)* is found in moist spots in about the same area. It is less slender than the bromes and has a large nodding, rather dense grayish-green panicle of small spikelets. It would make itself at home along a

rivulet or drain or where *Iris psendacorus* thrives. *Elymus striatus,* one of the wild-rye grasses, growing on banks above streams with drooping pale heads of spikelets with delicate curving bristles, would thrive in the same situations.

Bottlebrush grass *(Hystrix patula)* is already cultivated to some extent, but deserves wider use. On an open wooded slope a colony of *Hystrix* with its slender gray stems, spreading leaves, and swaying heads of horizontally spreading long-awned spikelets, suggests a dance of the nymphs.

Any of the broad-leaved panic grasses *(Panicum clandestinum, P. latifolium, P. boscii)* produce good foliage effects in perennial borders. In spring and early summer these have simple stems two to three feet tall and small panicles of little round spikelets. In midsummer the stems begin to branch, the upper joints fall away, the branches multiply and by September the effect is that of a miniature shrubby bamboo, quite Japanese in feel. They are picturesque beside a flight or two or three steps or at the end of a path. These grasses have the peculiar habit of producing close-fertilized seeds which remain enclosed in the sheaths. The chickadees feast on the seeds in winter.



The New Ornamental Grasses

Cortaderia selloana, *pampas grass, is a striking grass that is best used alone. It cannot be successfully grown where the temperature regularly falls below 10°F.* The grass is drawn to scale on page 23.

Drawings by Peter Loewer

One of the first nurserymen and gardeners in the U.S. to popularize the ornamental grasses and bamboos, describes some of the new cultivars coming on the market. —P.L.

Kurt Bluemel

In the last five years I have devoted a great deal of effort to introducing new ornamental grasses to the already growing number of varieties.

My effort has been directed at collecting and selecting good cultivars of *Miscanthus.* I also find it very important to make these new selections available to the public and the trade. *Miscanthus,* the ones we know, bloom late in the season (October-November). The flowers do not reach over the foliage and the colors of inflorescence are not very showy. At this time I am comparing over fifty species, varieties and selections of the genus *Miscanthus.*

Miscanthus 'Graziella' is a vastly improved selection of *M. sinensis* with narrow leaves, long stems and large silvery inflorescence well above the foliage, forming white seed heads reminiscent of ostrich plumes.

M. 'Malepartus' is very similar in habit but has a wider leaf. Both varieties bloom as early as the middle of August and reach six to seven feet when mature. It is winter hardy to USDA Zone 5. Both varieties have very good fall color.

M. 'Arabesque' is a dwarf selection three and one-half to four feet, early blooming (August) with golden inflorescence.

M. 'Sarabande' is a selection of *M.* 'Gracillimus' with a strong silver stripe in the middle of the leaf. This plant has a slender elegant appearance, blooming in September with silvery inflorescences and a mature height of five and one-half to six feet.

All the above selections are a great improvement over the *Miscanthus* offered in the trade so far; they are a different generation of the Japanese silver grass.

The following *Miscanthus* are of a different nature. The National Arboretum in Washington, D.C. made two very interesting variegated *Miscanthus* available for propagation.

M. 'Cabaret' is a broadleaf variegated selection, the white stripes running lengthwise on the leaf. Almost 70 percent of the leaf surface is white. Because it is so light, this plant can be successfully used against a dark background. It lightens a dark area, not unlike a garden light. The maximum height is four to five feet and the flowers are late (October). The plant is not used for the flowers but the foliage. It is hardy to Zone 6.

My favorite *Miscanthus* is the variety 'Morning Light'. I remember from old publications the name *"Miscanthus sinensis gracillimus variegatus",* which is very musical but unwieldy. The name 'Morning Light' describes the silvery glistening foliage, the narrow sharp leaves arching gracefully. The plant attains four to five feet in height and

Kurt Bluemel owns a nursery in Maryland and supplies most of the ornamental grass plants used in the nursery and landscaping business today. He continually searches for the new and the unusual in grasses and other perennial plants.

blooms in late fall (October). This *Miscanthus* is also planted for its foliage and would be beautiful in a "gray" garden; work it well with the blues, like *Veronica incana* or *Caryopteris* or *Perovskia*. Hardy in Zone 5, 'Morning Light' will make many friends in the future.

The following two varieties of *Miscanthus* are for the plant lover with a small garden area. *M.* 'Yaku Jima' from the island of Japan with the same name, grows three- to four-feet tall at maturity, blooming in the beginning of August with foliage that is narrow and silvery and has golden flowers. Safe to plant in Zone 7. Two clones are offered in the trade, one is more compact than the above mentioned. A very attractive use for this small *Miscanthus* is in between *Aster dumosus,* heather or heath, or other low-growing perennials.

M. transmorrisonensis, named after Mt. Morrison in Taiwan, is very graceful and reaches three to four feet maximum height and blooms in July with golden inflorescences that will sway in the gentlest breeze. The plant can be successfully used as a hedge or specimen plant in a perennial border, or used in large drifts to create a dramatic landscape picture in combination with masses of *Sedum* 'Autumn Joy' or *Sedum* 'Ruby Glow'; *Coreopsis* 'Zagreb' or *Coreopsis* 'Moonbeam'; *Rudbeckia* 'Goldsturm'; *Perovskia;* or lower-growing ornamental grasses such as *Helictotrichon, Sesleria, Festuca* or *Pennisetum* 'Hameln'. It is hardy in Zone 7.

Other new introductions are:

Imperata 'Red Baron' *(Imperata cylindrica rubra)* is making its successful entrance into many gardens. This 12- to 18-inch-high plant with brilliant red foliage looks best when backlit by the evening sun. Large plantings in combination with a chartreuse color grass *(Sesleria autumnalis)* or a yellow variety, *Hakonechloa macra aureola, Carex* 'Evergold', or *Alopecurus pratensis aureus* give a remarkable effect. *Imperata* does well in full sun and part shade. The grasslike *Ophiopogon planiscapus* 'Arabicus' is also a good plant to use in concert with 'Red Baron'; both are hardy in Zone 6.

Pampas grass, *Cortaderia,* from Argentina is not dependably winter hardy in Zone 7. *Cortaderia pumila* has been the hardiest pampas grass in Zone 7. It has survived many winters here in Maryland. This plant is valuable because it is only five to six feet tall and is a strong blooming selection, even a one year division will produce five to eight inflorescences the first year. It is a good specimen plant and can be used for cut flowers. This *Cortaderia* will be used frequently in the future.

Bamboos are all true grasses. Popular belief is that bamboos are the most invasive plants on this earth and this is partially true. There are hardy varieties that are not invasive called *Sinarundinaria.* These beautiful bamboos attain a height of 10 to 15 feet, are clump forming and hardy to minus 20° F. They tolerate a good deal of shade.

Bamboos, as a whole, are very graceful plants with their foliage and culms. An effort should be made to use this diverse plant to advantage. Invasive bamboos can be controlled by a running brook, concrete sidewalks, buildings or good structural elements buried to a depth of 30 inches. Deep shade will also hamper the rapid spread of some bamboos.

An established stand of bamboos creates a microclimate. Many animals and birds will make it their home.

Bamboo ground covers (Arundinarias and Sasas) are equally usable. Between walks, median strips, buildings and in hard-to-maintain areas, ground bamboos are hardy plants. The only maintenance required is cutting them back once a year and removing all the debris. Use the invasiveness to your advantage! Some bamboos make good house plants, such as *Phyllostachys nigra.*

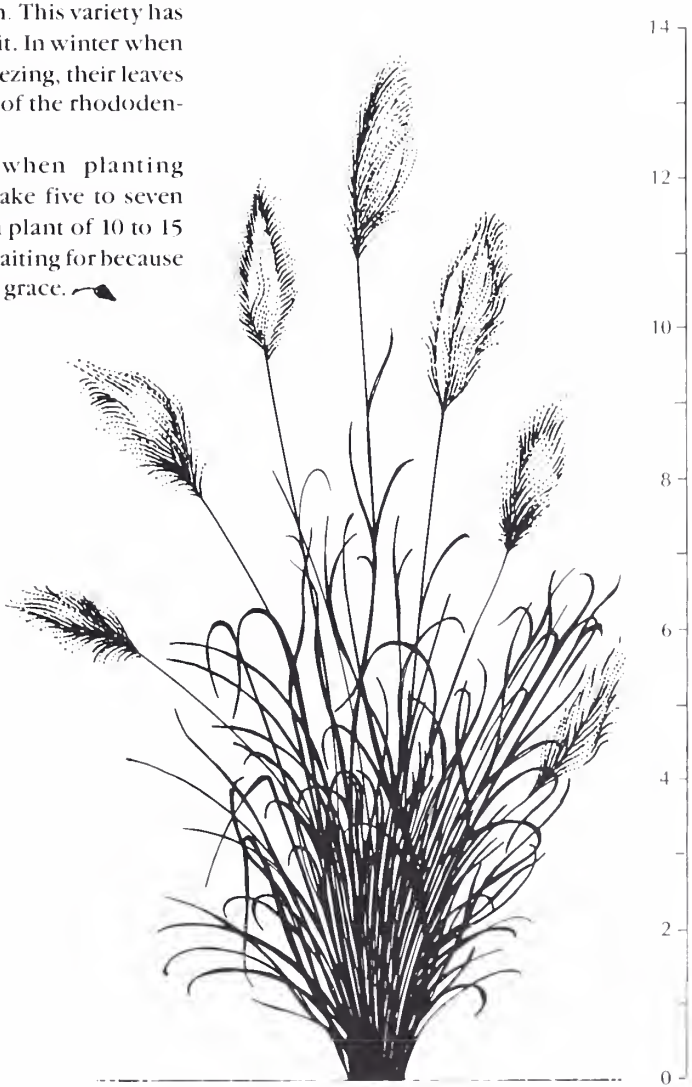
The names of bamboos are also causing a great deal of confusion. *Sinarundinaria* has had three name changes in as many years

(Thamnocalamus, Fargesia). Both of the following varieties are useful as specimen plants.

Sinarundinaria murielea is well suited for a shady spot. The true bright green color of the foliage is graceful and shows very well in the shade. The green slender stem, approximately three-fourths inch in diameter, arches gracefully. Few evergreen 'grasses' grow well in shade.

S. nitida is different because of its bluish appearance. The stems can vary in color but the purplish hue is prevalent. Stem diameter is three-fourths to one inch. This variety has a more upright growth habit. In winter when temperatures dip below freezing, their leaves will roll up like the leaves of the rhododendron.

Patience is needed when planting *Sinarundinaria.* It will take five to seven years to obtain a specimen plant of 10 to 15 feet in height. It is worth waiting for because few plants will rival their grace.



Cortaderia selloana

Gardening with Bamboo

by Elvin McDonald

Bamboo, whether dead or alive, remains one of the most-wanted plants in the world. It is inextricably linked with things oriental, yet a staple in the most Western of gardens. Hardly any serious gardener does without bamboo stakes and living bamboos come in all sizes and for all climates, from tropical to temperate where, with protection, the hardiest survive cold ranging from minus 10 to minus 20 degrees F. Richard Haubrich of the American Bamboo Society* recommends that bamboo be used as a hedge, a screen, as a specimen or as a shade plant. The introduction to bamboo that follows is based on information from Thomas Brothers Nursery (Cameron, N.C. 28326, a chief supplier of bamboo) and the U.S. Department of Agriculture.

Bamboo belongs to the grass family, Gramineae, tribe Bambuseae, and is distinguished by the special structure of its stem or culm, the fact that it reaches full height in a short period, its rapid rate of growth, and its singular flowering habits.

Elvin McDonald is a well-known author, photographer, and garden columnist who is an expert plantsman. He is the director of special projects at the Brooklyn Botanic Garden.

A Phyllostachys *species grows close to the entrance of this Japanese Garden. The fence itself is made of bamboo some of which is split.*

The characteristics of bamboo demand the use of two special words. "Culm" is used in place of trunk, which fits trees well enough but is inappropriate here since the culm grows so rapidly, has joints, and is hollow. Similarly, the generic "root" uneasily suits bamboo. Bamboo has indeed a very large growth below ground and also small roots prosper, but what distinguishes it—or at least many species—is the rhizome. This is a long and fast-growing underground shoot from which grow the new sprouts. It is the speed with which the rhizome travels underground that accounts for the spacing of the culms, each of which possesses its own system of small roots.

There are two main types of growth. Bamboo is found either in clumps of culms or as single, free-standing culm. Those marked "clumper" or "sympodial" are well-behaved. Those marked "runner" or "monopodial" can be invasive. In a grove the amount of rhizome intersection is formidable and this is the reason why such a subterranean network holds the ground so firmly. Each joint or node of this far-spreading rhizome bears a single bud yearly and some of these germinate to grow through the surface and become new bamboo. These single sprouts already possess in emerging the final diameter of the adult culm. The culms are erect and are clean of branches for a considerable height.

In all types of bamboo, the most striking characteristic is immense vitality. Bamboo, it seems, can overcome almost any kind of hardship. With its far-ranging network of growth

beneath the ground, all shoots are linked and nourish each other and propagate apparently without end. A grove at Hiroshima in 1945 at ground zero survived the atomic blast and within days sent up new shoots.

The speed of bamboo's growth is one of the wonders of nature. Koichiro Ueda, a Japanese authority, has reported one bamboo plant grew 47.6 inches in 24 hours. From the time when a sprout first comes through the ground to the completion of its growing, only about 60 days elapse. After this period, the bamboo culm does little; it gains no height, does not thicken, and it undergoes only slight change. It is alive, of course, indeed flourishing, and seeks sustenance avidly—though not for itself but to provide food for the sprouts that succeed it and for the network of rhizomes and young culms that constitute its family.

The vigor and fertility of bamboo is also remarkable. Every year there appear shoots in great numbers, which in turn produce more, and so it spreads until checked or disciplined by the gardener. Bamboo propagates by the branching of its underground rhizomes and does this asexually.

Even in the same planting there can be a difference of up to two months in the times in which sprouts appear from the soil. Generally, the earlier sprouts are best, developing into larger culms of higher quality. The main season for growth is spring to early summer. The age of the rhizome is relevant to which buds germinate. The three- to five-year rhizomes are the most fertile in producing new culms, while sprouts are rare from rhizomes older than age ten.

Bamboo culms grown in the same year and in the same planting differ in size. Mostly the large-size culms develop from the thicker, younger rhizomes. But even the sizes of the culms from the same rhizome can vary, depending on the amount of nutrients in the soil.

The culm grows so rapidly that it has no time to provide sustenance for itself and therefore growth is entirely dependent on nourishment received through the rhizome and the parent bamboo. The number of new culms in a grove

Water flows through a length of dry bamboo falling into a stone basin. This Japanese garden is in Portland, Oregon.

fluctuates yearly; normally, a good year alternates with one of lower production, although this can be controlled to some extent by fertilizing.

The leaves of bamboo fall yearly, but they give place at once to new ones. The monopodial or running species change foliage in spring, the sympodial or clumping species shed theirs in winter. Bamboo, like any other plant, gains much nutrition from its leaves. Those species

with a larger leaf area absorb more water and grow with more vigor.

When the conditions of the environment become less than favorable, the bamboo seeks security by developing larger leaves. This is especially noticeable after the rare flowering of bamboo, when the small regenerated shoots that do appear bear for a long while leaves which are unusually large.

Cultivation in the Garden

When bamboo is young, leave it uncut. This will encourage strong shoots to sprout every year and will enhance the quality of leaves. However, selectively thin the older culms every autumn. They are easily damaged by insects, and they also inhibit new shoots. Cut the large-culmed plants when they reach age five or six, the smaller culms at age three or four.

When the older bamboos are allowed to remain, the number of new plants is reduced, but these will in turn tend to be larger in diameter.

Severe pruning of individual bamboo culms is, unlike the pruning of other plants, discouraging to their growth and beauty. Bamboo may be pruned at its top in moderation; do this when

growth of the shoot is nearly complete and when one or two branches are beginning to appear from the lower part of the culm. Once done, a profusion of fresh leaves will grow in the following year.

To produce culms of larger diameter, leave the largest culms uncut since it is their characteristics that are transmitted to the next generation. In selecting culms to produce those of the largest growth, it is common sense also to excise the small or the unhealthy bamboo. Fertilization is essential to promote the healthiest growth and an increase in diameter.

Planting Bamboo

Bamboo is so versatile it can grow in almost any natural lighted area, from full sun to partial shade. Bamboo can be transported at any time of year by careful treatment. However, the best months for planting are autumn, early winter and early spring. Replant as quickly as possible to prevent rootlets from drying.

After transplanting, bamboo needs daily watering to the point of saturation for ten days, then on a regular schedule to maintain a moist soil. These plants are constantly in need of water and require a plentiful supply all year. But they also need to be in a well-drained situation—nothing swampy—whether in the ground outdoors or in containers inside.

While you're watering bamboos, they'll revel in a good misting to moisten the leaves and also to remove any dust that may have accumulated. This is of special importance to those grown indoors.

Bamboos do best in well-drained, light, sandy soil. Soil that is too dense and doesn't allow water to drain properly is a chief cause of failure. Indoors fresh air that circulates freely is a must.

The quality and yield of bamboo is much improved by fertilization. The culms become bigger and the healthiest dark green leaves appear. Bamboo consumes a considerable amount of inorganic nutrients, which are supplied in the normal course through the soil or by rain. But under intensive cultivation, not enough are naturally available and supplements are necessary.

Constant watering can deplete the soil of nutrients. Bamboos need an acid soil, pH 6.5 to 6.8. During the active growth period when new shoots are growing and leafing out, they can be fertilized as often as weekly. Nitrogen is the element most needed, followed by potassium, phosphorus and silica. Experiments show the most effective proportions for application are nine to ten parts nitrogen, five parts phosphorus, five parts potassium and six parts silica. The ideal quantity is about one pound of nitrogen per 100 square feet, with the other elements in proportion.

When a concentrated fertilizer is used, apply in earliest spring or a month before the sprouts are expected to appear above ground, and again in early summer before the best growing season of the rhizome. A balanced slow-release fertilizer such as Osmocote 18-6-12 or equivalent may be used.

When grown outdoors, bamboos go into dormancy or a resting period from autumn through winter. These times vary, depending on the area and severity of cold. *Bambusa* has a longer dormancy than other genera, lasting until the weather is dependably warm and settled.

Indoors, however, the dormancy diminishes and, in some cases, all but disappears. Some tropical species actually do better in an indoor environment.

When a bamboo is dormant it stops or slows external growth. Many of the indoor species will not go into dormancy but they will still periodically shed foliage. When this happens, throw the leaves back on the top of the soil. They add an interesting effect and provide the plant with a source of silica, an element beneficial to the plant's growth. These dead leaves form the best type of mulch. Enough of them can even decrease the amount of fertilizer needed. Conversely, an overabundance of falling leaves may be a sign of soil dryness, so be sure to keep bamboo roots properly moistened.

Phyllostachys nigra, *black bamboo, grows along a fence in this Japanese garden. This bamboo does not require as much water as some.*

Controlling Running Bamboo

Running bamboo spreads rapidly. Its growth must be restricted or it will soon form a thick jungle that extends many feet beyond the original planting.

A curb made of sheet metal, concrete or asbestos board will prevent bamboo from spreading. A ditching machine can be used to cut a narrow ditch around the grove and the barrier poured or built into the ditch. The curb must surround the planting. The top of the curb should be about one inch above the soil surface, and the curb should extend 24 to 30 inches into the ground. Any joints in the curb must be lapped and secured tightly; bamboo rhizomes can force their way through very small openings.

Buildings, wide driveways, and roads also restrict the spread of bamboo. If the bamboo is planted in a turf area, mowing will destroy unwanted canes by cutting them while they are still small and soft.

Unless the planting is curbed, rhizomes of a running bamboo will spread beyond the edge of the grove a distance approximately equal to the height of the canes. If you plan to grow bamboo

without curbs, be careful in choosing a planting site; protect yourself and your neighbor from unwanted bamboo in flower beds, hedges, and shrubbery plantings.

Bamboo Shoots for Food

The *Phyllostachys* species produce edible shoots. After shoots to be eaten begin to emerge from the soil, dig immediately. Use a narrow spade and push straight down into the soil on all sides of the shoot. When it is severed from the rhizome and the soil is loosened, pull the shoot from the soil.

Remove the sheaths from the bamboo shoot. First, cut off the bottom or approximately one-third of the shoot. Next pull off with the fingers the outer, tougher sheaths. Then cut off the tender inner sheaths above the growing point of the shoots and peel off.

The shoots of *Phyllostachys dulcis* have no bitter taste. All others should be boiled at least five minutes and the water discarded before they are cooked further or mixed with other foods.

This grass, Miscanthus sinensis *'Variegatus', is planted on either side of a bench in the Enid A. Haupt Garden at the Smithsonian in Washington, D.C.*

Bamboo for Interiorscaping

Source: *INTERIORSCAPE* magazine, July/August 1987

Sources

Field-grown *Phyllostachys nigra* 'Henon,' a tall, green cane type has been widely employed, often provided by Thomas Brothers, Cameron, N.C.

More recently, Florida growers have organized to produce a variety of bamboos for this market: *Bambusa tuldoides* and *Bambusa glaucescens* (fernleaf) from Tornello Nursery, Ruskin, FL; *Phyllostachys dulcis* and *Arundinaria sastuosa* from Naranja Nursery, Miami, FL. Also, from Hawaii, *Bambusa vulgaris* 'Vittata'.

One view is that the clumpers are better for interiorscaping because they won't invade open areas or girdle themselves into decline when containerized. Another view is that runners are better because northern genera such as *Phyllostachys* come from dry air, cool climates and require less water. The tropical clumpers are accustomed to high humidity and lots of water.

Designers' View

Bamboo serves a unique purpose for height (often in narrow space) and airy, willowy, non-tree appearance. The Hawaiian has large caliper canes with variegation, the potential for towering effect—but expensive. The domestic gives overall airy, lacy appearance and is relatively inexpensive.

Cultural Needs

Light: 800-2000 footcandles ideal; tolerant of light levels as low as 50-75 fc. *Bambusa* has proven itself at 125-400 fc for days of eight to nine hours duration. (Ficus trees tend to shade themselves out. The mantle of new leaves shades out the older ones so they fall off. Bamboo does not do this and thus tolerates less light than might be expected.)

Soil: Sandy, organic loam, well-drained. Ideal pH: 6.5-6.8. No more than 10 percent peat moss. High percent of leaf mold, supplemented with sand or soil. If not leaf mold, use odor-treated cow manure to add organisms that help break down nutrients in the soil. Soilless mix is not recommended.

Water Needs: Water freely. Avoid extreme drying (provokes leaf drop) and never leave standing in water.

Fertilizer: Time-release such as Sierra Osmocote 18-6-12, supplemented with liquid fertilizer every 45-60 days. A well-drained situation is mandatory, however, to avoid salt build up. Do not use a blossom-inducing NPK such as 15-30-15 or 1-6-5.

Miscellaneous Tips

- Containerized stock is preferable in situations where the indoor garden must look shipshape from the day of installation. Field-grown transplants go through a period of shock and recuperation before they are presentable.
- Emerging rhizomes should not be touched. They are as vulnerable as that of asparagus and will also readily snap or break if disturbed.

A woven bamboo fence provides a screen and textural interest in a west coast garden.

**The American Bamboo Society (1101 San Leon Ct., Solana Beach, CA 92075) annually produces a source list of bamboo plants, available free to any gardener who requests it and sends a long, self-addressed, stamped envelope.*

Bamboos in Flower

David McClintock

Bamboos are members of the grass family and many kinds are used in gardens for their decorative effect. But bamboos also have a mystique about their flowering habits, especially when one hears of Chinese pandas suffering when entire groves perish after producing blossoms. Mr. McClintock discusses bamboo flowering based on his experiences in England. —P.L.

In April of 1983, I published a note in *The Garden* on the flowering of the Himalayan *Arudinaria jaunsarensis* (as we must now call *A. anceps*). The response has shown that more can usefully be recorded about this phenomenon. For phenomenon it is. What brings a bamboo into flowering condition remains mysterious. The statement that the plants of a given species will all flower in the same year and then die, has been known for many years to be far from trustworthy, at least for nearly all the sorts we grow in England. Yet I hear it being repeated constantly.

I write "nearly all," because one species, the lovely *Thamnocalamus (Arundinaria) falconeri,* does seem to have a blooming cycle of roughly 30 years—never exactly the same—and when the bout has finished, all the plants die, mercifully leaving some seedlings. But in no other species can I detect such a clear interval between flowerings.

One difficulty is defining what is meant by flowering. It can occur as a single floret buried in a mass of leaves; it can occur on only one culm of a clump, or on only one clump of several; it can cover all the clumps in an area with flowers, or it may do this in every area everywhere, full gregarious flowering—the rarest form, at least in Europe. Furthermore the same plant can go on flowering, often quite profusely, for decades, with stamens appearing in suitable weather every month of the year.

Even with full flowering, it remains rare, in my experience, for a plant to die. While its strength goes into producing flowers, the leaves starve, shrivel, drop off, and photosynthesis slows down or ceases. But there is goodness stored in the rhizomes of well-established plants. Sooner or later the weakening bout will lose its force, and fresh shoots will reassert themselves, often starting with just one green leaf low down.

Meanwhile the plant will look awful, and many gardeners will decide that it was on the way out and dispose of it. If it had been left, it would most likely have recovered. I have seen this happen many times in many species.

Arundinaria simonii *var.* variegata *(left)*
A. viridistriata *(right)*
Bamboos are members of the grass family and many can be used decoratively along with other grasses. Use with caution because some can be invasive.

David McClintock is an English plantsman who writes and lectures extensively on the bamboos. He wrote about the bamboo family for the European Garden Flora *and his articles have appeared in* The Garden, The Plantsman, Amateur Gardening, *and the publications of the various bamboo societies.*

It is true that occasionally plants die following the debilitating effects of flowering. But this has usually been brought on by some other factor operating on the weakened plant such as extreme weather, or the plant being in an unsuitable site or not having had time to settle in—a big bamboo may need three years or more to get established in new quarters.

Seed is by no means always produced outside a plant's native area, or if it is, may not germinate. When any is found, it should always be sown fresh. The special importance of seed is the light that seedlings can throw on relationships of the plants we grow; we can classify beyond vegetative features. Varieties with variegated leaves rarely, if ever, produce variegated seedlings, but revert to their all-green progenitor—which sometimes leads to name complications.

Once a species starts to flower, nothing will stop it. If it is really full flowering, other plants of the same species may be expected to follow suit, and up to five years or more later, flower.

It may help to exemplify these general remarks with comments on some of the species on which flowering has been seen in the last year or so.

Arundinaria jaunsarensis has had flowers on this attractive, if invasive, bamboo for 25 years, never a year without. Furthermore there are clumps where I could find flowers, often plenty, year after year for as long as 20 years, and still do! During the past two years however, flowering has been on a much greater scale, but even so, there are still sterile clumps. Some of these may be seedlings from the early days of flowering, and it remains to be seen what sort of flowering pattern they may show. Seed production has been variable, mostly none at all, but sometimes quite plentiful and fertile.

Indocalamus (Sasa) tessellatus is an Indian species, floppy in habit because it has the longest, largest leaves of any bamboo on thin stalks. This used to be a standard example of a plant which never flowered. Nor has it anywhere, to my knowledge, except California from 1979 to 1982. But once our plants had good flowers, its stamens could be counted to determine in which genus it belonged—it has three, whereas *Sasa* has six. So flowering made accurate classification possible, and changed the generic name.

Pleioblastus chino is a relatively ordinary bamboo, up to seven feet tall with medium-size leaves, and it runs. It has been an overlooked species, given various other names until recently, but is not rare. I have flowering specimens for one or another variety for 1966-67 and since 1979. But this seems to have been only spasmodic, often the leaves hardly suffering and, at least once, massive flowering on one culm in one clump in one year and never any more since. Seed has been variably produced, sometimes in quantity, and has germinated well.

Pleioblastus variegatus (Arundinaria fortunei and *A. variegata* in *Hortus Third*) is a nice plant with two forms at least; one gets up to three feet, the other stays half that size. Both started to flower in a small way in 1976, and are slowly spreading, but many clumps remain sterile. The leaves are narrow, dark green with white stripes, but the seeds will produce only green-leaved plants. They are still *P. variegatus,* but differentiated as var. *viridis.* In addition to the present bout, this species flowered 15 years earlier in Copenhagen; the seedlings were also all green.

Pleioblastus viridi-striatus (Arundinaria auricoma and *A. viridistriata* in *Hortus Third)* is even lovelier with broad golden yellow leaves and pale green stripes, growing to five feet in height. Its leaves look best if the stems are cut down early in the year, but if they are not, solitary spikelets may be found on top of some of the stems, without the leaves being affected in any way at all. I have yet to find seed to prove its postulated green origin.

Phyllostachys species can readily be identified by culms having a marked groove between alternate nodes, where there are two unequal branches with sometimes a thin

third one between them, these similarly grooved. None of the species most frequently grown seem to be flowering here at the moment, but one more commonly grown on the continent can be seen in the bamboo garden at Kew, *P. aureosulcata*. It has, as its name denotes, a yellow groove on its rough greenish culms and *P. nuda* has also started to flower there (*nuda* from having no bristles on its sheaths). Other species should soon flower if there is anything to their claimed cycles. *P. aurea* in particular is "overdue," as was reported to me from Sweden in 1982. I have heard of no more, but have a seedling germinated from their seed. That species has a cup-shaped swelling beneath each node.

Pseudosasa (Arundinaria) japonica must be our most common bamboo, surviving maltreatment and neglect. But even when it is well grown, it is no more than "Yet another bamboo"—well, that is my opinion, and I have groves of it! In my poor sandy soil it can exceed 12 feet, and normally stays in tight clumps with only an occasional wandering rhizome. Five years ago I called its flowering "scrappy, irregular and unpredictable," and so it seemed. But after I wrote in *The Garden,* the majority of specimens sent me were of this species and not *A. jaunsarensis.* These are probably our two most frequently grown species, and it so happens that both have been flowering for two decades or more in varying degree, but profusely in the past two years or so. Even so, not all clumps have flowered.

Sasa kurilensis is another bamboo more common abroad than in England. There are two forms under this name, one a dwarf of not more than eight inches, the other up to eight feet. (Editor's note: the dwarf turns out to be *Pseudosasa owatarii.*) Both have been flowering quite generally since 1979. This is another dullard, the small one like the neater *Pleioblastus (Arundinaria) pygmaeus* (on which no flowering has lately been noted, another value of flowering records). The taller rather resembles *Pseudosasa japonica.*

Sasa palmata is a fearsome runner, sometimes six feet a year. But where it can be contained or accommodated, it is worth it for its superb large, very broad (up to four inches) leaves, bright green for 12 months of the year, atop six-foot stems. It has flowered endlessly from 1961, and still has not finished. Seed is rarely produced and the only germination I have come across was a self-sown seedling.

Sasella ramosa (Arundinaria vagans) is another rampant species, three- to four-feet high with a single wide branch at each node, and leaves that may get a narrow dead edge in hard English winters. Forms of this had been known to flower in its native Japan, but never anywhere else. Then suddenly in 1981 a single patch at Kew burst into full flower and produced seeds (but I have yet to hear of germination). This particular patch lost its flowers after two years, but flowering spread to other patches, and has since been noted in widely separated places—on the continent too—but there are still many flowerless patches. There is no sign of the plants completely dying, despite the vigor of their flowering.

Semiarundinaria (Arundinaria) fastuosa forms towering clumps with a bunch of short branches at each node. It has been flowering since at least 1957. I watched the same clumps flowering incessantly year after year for over 20 years. During that time many gardeners lost patience and grubbed them up. Those that did not now have 12-foot culms in full figure. Even so, there were flowers still in 1983 at Kew, but never a seed anywhere.

Herein I mention only the most frequent or relevant species that may be seen in flower at the time of this writing in 1984—of which there are some half dozen more at least. There are also about a dozen which so far have never flowered here; one or two have never been known to flower anywhere. Only when we have accumulated much more data —the most valuable coming from observations of the same clump over many years— may we be able to realize what causes bamboos to flower.

Ornamental Grasses

Molina caerulea *'Variegata', purple moor grass, is a blue grass and is clump forming. The flowers are borne in archings sprays and are purple.*

Drawing by Peter Loewer

Grasses to the horizon moving like a sea in the wind are far from the decorative clumps found in garden borders. But between the giant bamboos that grow ten feet a season and the dwarfs of our lawns, there are grasses whose effects in well-considered combination with other plants, are as beautiful as a meadow.

Pamela Harper

During the last five years there has been a surge of interest in ornamental grasses. The landscape architects Oehme, van Sweden & Associates of Washington, D.C. have had a lot to do with this. They have demonstrated how beautiful grasses can be, not only in private gardens, but in such conspicuous public places as the parklike area around the Federal Reserve Building in Washington. Some of the thousands of visitors to the nation's capital will certainly have gone home with new ideas for their own gardens. A frustrating search for the plants may have followed but the situation is improving, though demand still often exceeds supply. Making a choice among over a hundred listed grasses might now be the problem. Many are new to me, especially the prairie grasses. One little gem among these is mosquito grass, with tiny pink and white combs of flowers held obliquely to the stalks and seeming to hover; a curiosity for the rock garden. Other than this I'll confine myself to familiar grasses, using the term loosely to include a few sedges, reeds and rushes.

Many annual and tender perennial grasses are grown for their inflorescences, to be admired on the plant or dried in bouquets. Seed catalogs illustrate quite a lot, with such evocative names as animated oats, cloud grass, golden-top, bridal-veil and ornamental corn. Quaking grass, *Briza maxima,* has been grown by generations of gardeners for its panicles of pendant lockets quivering on wire-fine stalks. This is an annual, and so is the scaled down *B. minor,* but *B. media*—also known as trembling grass, shakers and doddering-dickies—is a hardy perennial, about 18 inches high, deciduous, but almost evergreen in mild areas. At the front of a flower border its trembling fat spikelets, green fading to beige, add a light touch to the brighter colors.

Fountain grass well describes the four-foot flowering clumps of *Pennisetum setaceum (P. ruppelii),* variable in color but rosy pink in the preferred form, sometimes grown as an annual. Where frost is infrequent it is perennial, as in California, where it is frequently planted, but clumps may rot in winter in wet soil. No sun seems too hot for this drought-resistant grass, but wind can leave it very battered. It is a pest if plumes are not cut before the seeds fall, but the dark-flowered, dark-leaved *P. setaceum* 'Cupreum' is said not to set seed although this needs to be confirmed in California. Excessive self-seeding seldom occurs in colder areas, where the dead plumes of this and the hardier, but less colorful *P. alopecuroides* are left for winter interest.

Pamela Harper is the owner of the Harper Horticultural Slide Library and one of the premier garden and plant photographers of the garden world. Her book, The Story of a Garden, *chronicles the creation and development of a garden by Mrs. Harper and her husband Patrick over a period of sixteen years. She is the co-author of* Perennials, How to Select, Grow, and Enjoy.

Bamboos

I could say much about bamboos, and little of it polite. Several proverbs apply: "give them an inch and they'll take a yard," "once bitten, twice shy." Bamboo must have caused more friction between neighbors than any other plants because the taller ones seem so suitable for boundary screens; unfortunately, stoloniferous bamboos recognize no boundaries, and most of the clump-forming kinds are rather tender. If I did feel inclined to try a hair of the dog, it would be with *Chusquea culeou* or *Arundinaria viridistriata*. *Chusquea culeou* is Chilean and Chilean plants are noted for two things: their beauty, and their poor adaptability to other climates. So it would be a gamble, but one worth taking in mild climates where it could be given moderately moist, fertile soil and shelter from wind. Plumelike stems of slender, two-inch deep green leaves comprise the dense, ferny, slightly vase-shaped, exceptionally graceful non-invasive clumps, seldom more than eight feet high though capable to twice as much. Unlike most bamboos, the canes are solid and the leaves do not wilt when stems are cut. Mature canes are clad to the base with short leafy branches but first year canes are bare, very dark green and punctuated with conspicuous white sheaths from the nodes.

The other bamboo that tempts me from time to time is hardier but less restrained, and I've seen it escape too often to put my trust in bottomless tubs or flue pipes sunk in the ground, let alone the old tires sometimes entrusted with the job of containing it. *Arundinaria viridistriata* seldom grows as much as waist high. An earlier species name, *A. auricoma* (having golden hair) was apt, because the effect is of a vividly yellow plant, and young leaves are velvety. Look closer and you find that the spear-shaped mature leaves vary: yellow; pale green; yellow flushed green; green flushed yellow; or yellow with green pencil-striping. Raised containers, or beds surrounded by paving set on a concrete slab will keep it in its allotted spot. The color is brightest in full sun which may, however, scorch or curl the leaves, especially if the soil is dry. Each gardener must experiment to find the best place. Hard frost kills the leaves, but they stay on the plant—shantung colored and with a silky sheen when struck by the low rays of the sun.

For those averse to yellow foliage, there's a white and green counterpart in *Arundinaria variegata*. For more about bamboos, turn to *New Western Garden Book*, where thirty-six are described.

Pampas grass

Cortaderia selloana is too imposing to be a good mixer and most fittingly stands alone in grass or paving. Where hardy it is easy to grow, even below high tideline on the beach. In California care must be taken in planting pampas grass to be sure that *C. selloana* is used and not *C. jubata*, which is an invasive pest throughout the state. For gardeners deprived of this because winter lows fall regularly below 10°F, there's an equally impressive substitute in *Erianthus ravennae*. Less bushy but loftier plumes, rearing up 10 feet or more, have the spun-glass lucency of a squirrel's tail against the light. The foxy brown winter color is also very appealing—all in all an underappreciated plant for fertile, moist but well-drained soil, hardy well below zero, though with the risk that the flowering plumes may be damaged by early autumn frost.

My resolve never again to grow pampas grass, after cutting myself on the saw-edged leaves while trying to hack a clump apart, weakened at sight of the cultivar 'Gold Band' combined with gray artemisia and blue agapanthus, the prettiest association seen during a three-week gardens tour. The name misleads, it is striped, not banded. I bought it, it died, and its place has been filled by *Miscanthus sinensis* 'Zebrinus', which really is gold-banded. There are hundreds of plants with vertical striping but very few with horizontal

Here is an Oehme,van Sweden design containing Calamagrostis epigeos, Miscanthus sinensis *'Gracillimus',* Pennisetum alopecuroides, Yucca recurvifolia *and* Pinus mugo.

Photo by Pamela Harper

bars, which go "against the grain" so to speak. In the moist (even wet) soil preferred by these plants, 'Zebrinus' stands shoulder high, topped through autumn and winter with feathery plumes. *M. sinensis* 'Strictus', called porcupine grass, is similar but shorter, narrower and more upright. At least a dozen other cultivars are obtainable, of which 'Gracillimus', a four-foot fountain of narrow ribbons, and white-striped 'Variegatus' are easiest to find and among the best. When to divide or transplant grasses depends on where you live. Transplanting should, ideally, be followed by the longest possible period without excessive cold, heat, drought, wind or rain, but the ideal must sometimes yield to expediency. In prying off a chunk of 'Zebrinus' I broke a fork and nearly my back, so anyone much over forty years of age might do well to tackle the job whenever they happen to have a strong man with saw, mattock and axe. If in doubt about the plant's survival leave part of the clump where it is as insurance.

Pennisetum setaceum *is combined in this garden with* Cleome *'Helen Campbell',* Senecio cineraria *'Diamond',* Catharanthus *'Little Blanche' and* Salvia farinacea (white).

Reeds

Two impressive grasses of somewhat similar appearance are the giant reeds, *Phragmites australis (P. communis)* and *Arundo donax,* wetland plants invaluable for beautifying low-lying wasteland, as phragmites does long stretches of East Coast interstates. Both have Jekyll and Hyde characteristics, being extremely invasive in wet soils but quite likely to die in dry ones. Of several cultivars, only *Arundo donax* 'Versicolor' seems to be available; this is reminiscent of sweet corn but with each leaf striped in cream and green broadly margined with white. It is cold-tender (more so than other plants of the species), vagrant, and the leaves may scorch in dry climates, but effort to overcome these shortcomings as best you may is well worthwhile for this showiest of all variegated grasses.

If a plant is attractive, fairly easy to grow, and not too difficult to propagate, it is well on the road to popularity, but not necessarily universal popularity. Having met those requirements, a less obvious factor comes into play, one I became aware of on moving from England to the southeastern United States and found that yellow foliage had lost some of its appeal; the psychological effect is different under sunny skies. On the East Coast many grasses, wild and cultivated, are most appealing in autumn and early winter. As the year explodes in a climax of brilliance from the trees, the dead stems and leaves of deciduous grasses have the same tawny gleam as the sun-lit coat of a golden retriever, while the plumed or hazy inflorescences assume a radiance in the Indian-summer sunshine unexcelled by any other plant. Deciduous grasses favored by Oehme, van Sweden & Associates for this effect include the three foot vertical clumps of *Calamagrostis* ('Karl Foerster' is a particularly fine cultivar), arching *Pennisetum alopecuroides,* and *Miscanthus sinensis* 'Gracillimus' with its slender weeping leaves and feather-duster plumes. By combining these with evergreens such as yuccas and mugo pine, foreground ground covers such as epimediums and bergenias, and perennials that stay long in bloom and remain attractive when dead, especially *Sedum* 'Autumn Joy' and *Rudbeckia fulgida,* a picture is created that changes with the seasons and never lacks interest. Sometimes the grasses are massed, sometimes well spaced among rocks and gravel. The grasses remain effective through most of winter and are never more appreciated than when rising above a sparkling carpet of snow.

But what of regions where summers are dry, winters mild, and rainy autumn heralds not a winding down but a resurgence of growth? Might green better suit the mood of this new growing season? In any event, dead brown grasses are seen at their best where autumn is sunny and comparatively dry; under persistently gray skies they may look drab and rain-bedraggled. There are evergreen sedges from New Zealand (*Carex buchananii* is one) which are always brown or copper colored; might these be in keeping where brown is the characteristic color of the summer landscape, or would they seem to have died of drought? I'd need to live there to know. These coppery sedges are uncommon and names are confused: *Carex buchananii* should be V-shaped, but a grass of weeping habit (equally desirable) sometimes bears this name.

Most of the reeds and rushes and some of the sedges need or prefer marshy soil or shallow water, and so do a few of the grasses, but those mentioned next will also grow in soil only moderately moist. *Acorus gramineus* 'Variegatus' (an Aroid) makes gappy foot-high clumps of sword-shaped leaves grouped in narrow fans. Roughly half the quarter-inch width of each leaf is green, the other half cream; it looks more at home in a manicured setting than a naturalistic one and never better than when growing through pebbles in a pot.

Umbrella-plant, *Cyperus alternifolius,* makes a good pot plant for those who find it hard to gauge the right amount of water. Overwatering is almost impossible, and underwatering can be guarded against by standing the pot in a water-filled outer container. In summer, or year round in warm climates, it

can be plunged in a garden pool or grown in a moist border. An elderly lady told me she got new plants by cutting off the "umbrellas" and putting them upside down in shallow water (hers were in the bird bath). I was sceptical, but tried it, and found she was right. It is killed at 20 °F, as are most of its kith and kin but not, unfortunately, that beautiful but pestiferous weed, *Cyperus esculentus* or nut grass, seed of which is sometimes offered for sale; avoid it like the plague.

Variegation

Bowles' golden sedge might be found under *Carex stricta* 'Aurea', *C. riparia* 'Bowles', or *Carex elata* 'Bowles' Golden'— they are all the same thing, and a lovely thing it is, with slender flexed leaves about two feet long, seemingly pure golden yellow though actually thinly margined green. The color is brightest in full sun, and wet soil alongside a pond or stream is the perfect spot for it. It isn't a beginner's plant, being often difficult to establish. Don't confuse it with Bowles' golden grass, *Milium effusum* 'Aureum', a graceful yellow-leaved wood-millet, easily grown from seed, and a cheerful plant for heavy, moist soil in partial shade.

Three rather similar, winter-dormant wetland grasses grown for their striped ribbon-like arching leaves are: *Glyceria maxima (G. aquatica)* 'Variegata', or manna grass, about four feet high with leaves striped cream; *Phalaris arundinacea* var. *picta*—the ribbon grass or gardeners' garters, of similar height with leaves striped white; and the taller *Spartina pectinata* 'Aureo-marginata' with leaves striped yellow. Assessed solely on appearance, my own first choice would be glyceria, which is at its best in mud or shallow water. Spartina would be the one for brackish marshes. Phalaris, besides being beautiful, is exceptionally hardy (to about—30 °F.) and will grow in quite dry soil. All three are determined colonizers, phalaris less so in dry soil but it still needs watching. *P. arundinacea* 'Feesey's Form' is said to be superior and non-invasive, and 'Dwarf's Garters' is a shorter, twelve-inch, variegated cultivar.

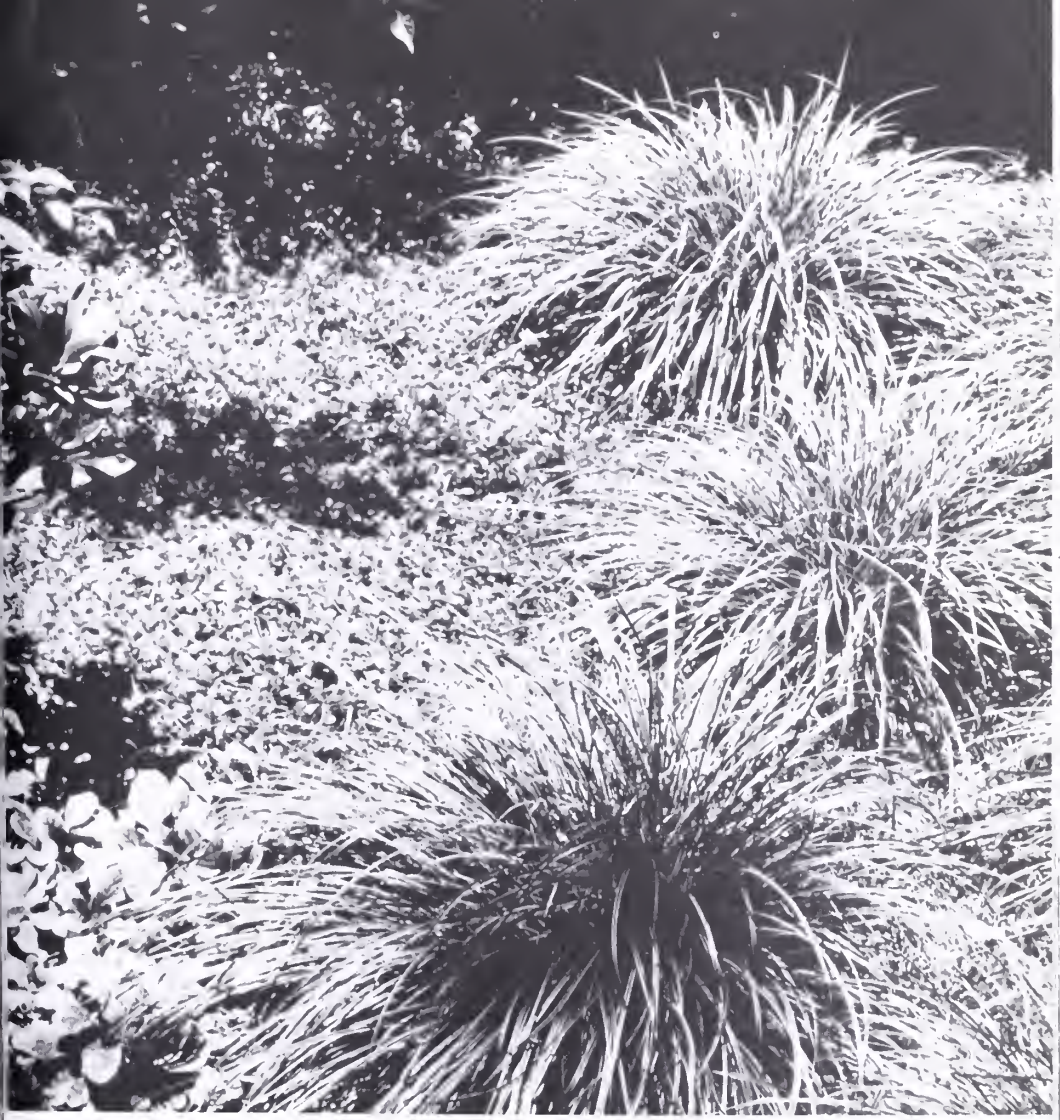
Gray and Blue

Now a group grown mainly for the appeal of their living leaves, though most also have attractive flowers. Trying not to play dog-in-the-manger, I'll put the blue ones first. On acid seashore sand in Virginia these are among my failures; humid heat and high rainfall is probably what upsets them, as it does a lot of gray-leaved plants.

Most gardeners know blue fescue, usually sold as *Festuca glauca*. *Hortus Third* calls it *F. ovina* var. *glauca*. In his recent book, *Ornamental Grasses,* Roger Grounds calls it *F. caesia*. Kurt Bluemel calls it *F. cinerea* 'Superba' and lists also the cultivar 'Blausilber'. Under whatever name, blue fescue makes pattable cushions of soft, needle-fine blades six to eight inches high, not good for massing because the tuffets maintain their individual rounded shape and insinuate themselves into the gaps. Crowded clumps may rot, and even well-spaced ones get shabby if not divided every year or two. *F. amethystina* is a similar but taller plant of 18 inches or so.

Of similar color, but taller and of firmer outline, *Helictotrichon sempervirens (Avena sempervirens)* seems to demand a formal setting—perhaps a single plant in paving, or a group of three well-spaced clumps growing through a ground cover of pebbles. Slender spiky leaves grow upright at the center of the clump, those at the edges are arching. When topped with stalks of loosely clustered grayish flowers the plants reach four feet in height. Sandy soil in sun is said to be their preference. Metallic blue and broader bladed, plants of *Elymus arenarius* are of more relaxed mein—rather untidy in fact. Though lauded by no less a personage than Gertrude Jekyll, I'd hesitate to admit to my garden a plant of such incurable exuberance. It is a seashore plant, sometimes used for stablizing dunes, but the handsomest planting I've seen was in wet, heavy clay; which only shows that you can't always go by the book.

The only blue thing about *Molinia caerulea* 'Variegata' is the name. The flowers are sometimes purplish and purple moor grass is one popular name. There's gentleness about



Carex conica *'Variegata' has leaves little more than one-eighth inch wide, dark green edged with white. It is combined with* Ajuga *'Burgundy Glow' and* Mazus reptans.

this plant, the leaves limply arching, the creamy striping merging with cream stalks holding aloft slightly arching sprays of brownish or purplish flowers to a height of two feet or so. It is clump forming, blends with almost everything, does well in sun or part shade and adapts to most soils not excessively wet, dry or alkaline. It is hardy at 25 °F but the leaves turn brown with the first frosts.

Yellow

Hakonechloa, from Japan, is a winner. Plants of *Hakonechloa macra,* with green leaves are not being sold, though they are in cultivation. Three cultivar names appear in literature but all the plants I've seen have been the same. White Flower Farm (Litchfield, Connecticut 06759) claims to have introduced it to the United States and they give it the name *H. macra* 'Albo-aurea Variegata'. It is the same plant as *H. macra* 'Aureola' of English gardens. Moist, humus-rich acid soil suits it best, with shade from direct sun where summers are hot. Slowly spreading clumps combine dramatic color with delicate texture and graceful form. They look yellow, but

each slender tapering blade is pencilled with green and sometimes flushed pink or bronze. It is flowerless so far and there seems to be doubt about whether it belongs with the grasses or the bamboos. *Alopecurus pratensis* 'Aureo-variegatus' has similarly brilliant coloring on a denser, more upright plant, scarcely 18 inches high with cylindrical clusters of flowers held well above the foliage. Grow this in full sun or part shade, in fertile well-drained soil. Clumps spread moderately fast but an infestation need not be feared.

Variegated bulbous oat grass, *Arrhenatherum elatius* 'Bulbosum Variegatum' is easily recognizable, if you dig a bit up, by the chain of maize-shaped basal nodes, each capable of making a new plant. This is one of the prettiest grasses, with clean white striping and dainty flowers. In my garden it tries to go summer dormant, doesn't quite manage it and hangs about looking shabby. It smartens itself up for a couple of months in autumn and then goes dormant with the coming of cold weather. It may behave differently in other climates.

Problems

Finally—though not because the topic is exhausted, I've barely scratched the surface—two current favorites. Attempts to unravel the tangled names of these two somewhat similar sedges have met with only partial success. They resemble each other in size and habit: in moist leaf mold and partial shade fist-sized divisions have made dense clumps 18 inches in diameter after three years. Each slender leaf is over a foot in length, but because they arch or spread sideways, the height of the clumps is little more than eight inches. The tough, once-pleated leaves look glossy and smooth, and they feel that way if you run your fingers from base to tip, but rubbed the other way they are raspy towards the tip. So much for similarities, now the names and differences. From sundry names thrown into the pot by catalogs, articles, reference books (no two of which quite agree, nor do their descriptions precisely match the plants before my eyes) and learned friends, I have picked the two I think most likely, with other names under which they might be found in parentheses. Both plants are from Japan.

Elymus arenarius *has broad-bladed leaves of metallic blue and is an unruly plant. Here it is contained by a barrel. A striking specimen.*

Carex morrowii 'Aurea-Variegata', or 'Aureo-Variegata', or 'Variegata Aurea' *(C. morrowii* var. *expallida, C. morrowii* 'Variegata', *C. morrowii* 'Evergold') has leaves one-quarter inch wide. Sometimes the striation is a bit more complicated but most of the leaves are deep cream in the middle with a fairly narrow dark green edge. The overall effect is a showy creamy yellow in combed clumps from which fallen leaves are easily raked. In my garden this plant does extremely well if given deep, moist soil and some shade from afternoon sun. It is an undamaged evergreen down to 20 °F, is shabby at lower temperatures and perishes at about zero. It is not uncommon, and all seem agreed that it belongs to the species *C. morrowii.*

Carex conica 'Variegata' *(C. morrowii* var. *expallida, C. morrowii* var. *albo marginata, C. morrowii* 'Variegata') has leaves little more than one-eighth inch wide, dark green very narrowly edged with white. The somewhat silvery effect is less dramatic and easier to blend with other plants. Though preferring rich, moist soil and part shade it is more tolerant of sun, drought and poor soil than its counterpart. It is also a great deal hardier, to well below 0 °F for prolonged periods. It is primarily on the basis of this greater hardiness that I have accepted the probability of its being distinct from *C. morrowii,* though doubt remains. Both plants are lovely, singly or in drifts, but the second is the more versatile. I have distributed it as *C. morrowii* 'Variegata' and it is doing well in the gardens of West Coast friends from Seattle to Los Angeles.

Ornamental Grasses of the Southwest High Plains

From the mountains of the Southwest come a different class of ornamental grasses that are more subtle and modest than many of our usual garden grasses. —P.L.

Gail Haggard

I am writing about a few of the ornamental grasses of the high elevations of the southwest plains, an on-the-dry side, magnificent area of grasslands.

Ornamental has many meanings. If my children play in it, or if I eat it, I consider it to be of the highest ornamental value.

The ancient corns come to mind: blue corn, papago, desert sweet . . . they are grasses offering ornaments to my plate. Large cobs of gun-metal blue and rainbow corn, and the tiny cobs of strawberry corn, are given at every holiday and birth because of their lasting beauty and as a reminder of our means of sustenance and good fortune. Some of the most intriguing gardens of the Southwest have corn in their ornamental borders—again the huge varieties like papago, or the diminutive like strawberry corn—along with other vegetables and colorful flowers. A well-known Santa Fe restaurant has a narrow bed of corn and sunflowers on the street—it's a landscape delight and a traffic stopper. Maize mazes are a child's delight. When we were little we all played in the corn patch. It was thick and high overhead, a hide-and-seek heaven.

The sweeping ornaments to the eye are either the grasses in the untouched plains,

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Gail Haggard is the owner of Plants of the Southwest, a marvelous seed house located in Santa Fe, New Mexico, and well-known for its commitment to ecology and the relationships between rocks, plants, earth and weather.

"All flesh is grass."
The Bible

"Grass is the forgiveness of nature—her constant benediction."
John James Ingalls

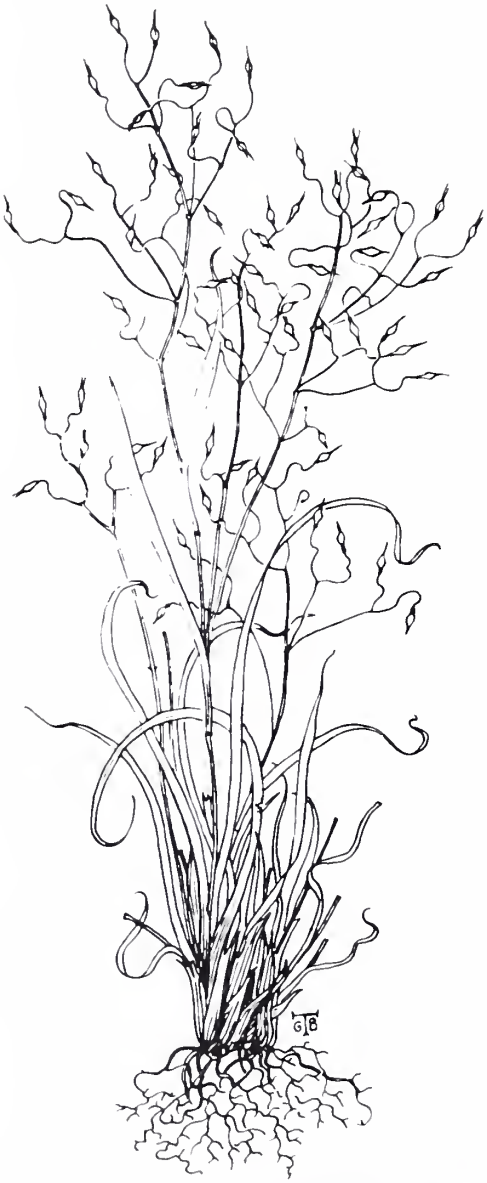
their more diminutive relatives of the grass meadows, or the native grass lawns. Lawns and meadows in our dry country shouldn't be composed of expensive-to-maintain imports like Kentucky bluegrass (an appropriate beauty to another climate.) The glories of the high plains are the native grama grasses —modest, subtle, but certainly beautiful.

Blue fescue is a familiar grass. It is propagated by division from the bluest form of the native, *Festuca ovina glauca*. It's a blue, perfectly symmetrical hedgehog if trimmed, and if let go to seed, waving open seed heads on stems to four feet appear above the blue base. Try blue fescue in perennial beds, making a checkerboard pattern with soil in between, as an accent in a corner spot or in your rock garden. It is corny and true that a rock is a plant's best friend. The plant can snuggle up to its favorite exposure, get heat in the winter, coolness in the summer, and have the extra water that the rock gives by condensation. A low grass like buffalo grass *(Buchloe dactyloides)* planted between flagstones is another example of this delightful companionship.

Seed-eating birds are attracted to Indian ricegrass. The American Indians collected its seed to grind. The genus, *Oryzopsis* has been a food source worldwide. The seed stalks

Bouteloua gracilis, *blue grama grass, is a native warm-season grass. Its leaf texture makes it a superb alternative lawn grass.*

Drawings by Niki Threlkeld



Oryzopsis hymenoides, *Indian ricegrass, grows one – to two-feet tall, prefers sandy soil and is extremely drought resistant.*

make an airy, delicate cloud about the leaves of this bunch grass—beautiful in the meadow, as an accent in the garden, and in dried arrangements. Indian ricegrass *(O. hymenoides)* grows one to two feet tall, prefers sandy soil and is extremely drought resistant.

Little bluestem *(Schizachyrium scoparium)* grows across the Great Plains. Western cattle were driven to its luxurious domain to be fattened up. It's a feast for the eye as well: a tall (three feet here where it's high and dry) bunch grass whose green leaves and stalks turn russet in the fall and look so striking against the snow. The fuzzy seeds that fly to the winds catch the light.

Side-oats grama *(Bouteloua curtipendula)* does not have the leaf texture that makes blue grama *(B. gracilis)* a superb alternative lawn grass, but it surely holds rocky slopes well and, as the name states, the seed is like little oats all lined up on the side of the stalks. Best is the orange-red color of the delicate male part of the flower and, up close, the feathery brush of the female part of the flower—unfortunately only a delight for the close observer.

There is so much more: the blue cast and the strict symmetry of the seed heads of the wheat; the open pattern of alkali sacaton *(Sporobolus airoides)*; the other grass flowers that resemble ocean waves.

The most important category of ornamental grass use is for the lawn—and I hope, more and more, for the meadow. Others have stated their concern more forcibly than I. Charles Mann: "The traditional sod lawn is a conformist nightmare, characteristic of mass mentality, lemming behavior. It is a disaster perpetrated against everyone's best interest by sheep accustomed to "eating" inferior, expensive products."

A local homeowner in our Santa Fe area kept a monthly record of water bills over two years for installation and watering an 8,000-square-foot lawn of Kentucky bluegrass and another of buffalo grass. After installation of the lawns—the bluegrass totaled $6,000 for sod or $4,000 for seed and the buffalo grass was $3,500 for sod or $840 for seed—the maintenance for the bluegrass continued at approximately $415 per year, every year, for water; the buffalo grass cost $150 the first year and nothing after that.

Even if a native lawn were more costly (and that could never be), I'd prefer it. Native

grasses are softer with finer leaf blades and are easier to maintain: there is no mowing or edging weekly, no thatching, no fertilizing. It is more disease resistant and if I went on an endless hike, it would be just fine when I returned.

Native grass alternatives such as blue grama or buffalo grass are warm-season grasses. Kentucky bluegrass is a cool-season grass. The warm-season grasses are green while growing during the summer, turning beige and going dormant when it gets cold. Cool-season grasses do their growing in the spring and fall when it is cool. They are dormant in the summer unless they receive a lot of water to keep them actively growing. This is an important visual difference if you move to the Southwest: less green, more beige.

A large specimen of Indian ricegrass, Oryzopsis hymenoides, *will attract seed-eating birds. The Indians also collected the seed to grind. The seed stalks make an airy, delicate cloud above the leaves of this bunch grass.*

A West Coast Garden of Grasses

A California gardener writes about her favorite—and not so favorite—ornamental grasses and how to use them in a garden.

—P.L.

Hermine Stover

That last fateful childhood day in Brooklyn, as I watched an agonized, red-faced man push a lawnmower uphill to level a surface of live green outdoor carpeting, I vowed: "No lawns for me!" But I didn't give up on grasses; on the contrary, I threw myself into collecting and growing ornamental grasses and grasslike plants. I have never mowed a lawn, nor have I lived a day without enjoying the sight of a grass. Those plants which botanists call Gramineae are the true grasses. However, other plants which are grassy in appearance are included here. Some of these are members of the lily and iris families, or other less familiar monocots.

The grasses I grow range in color from carbon paper purple-black to shameless bright pink; from solid color to gaily striped and banded; from tiny plants best appreciated in an equally tiny Japanese pot to massive individuals which take the place of shrubs in the landscape. If I include the bamboos, those woody perennial grasses, I may say that I can garden using plants that vary between tiny tufted ground covers and huge trees, in a rainbow of colors, and still deal only with ornamental grasses.

Grasses and grasslike plants embrace a broad spectrum of climates from swampy, boggy places to arid and rocky locales. The bog plants—which are my personal favorites—include *Acorus*, an aroid which resembles an iris, and comes in solid green, white striped, and in a range of sizes from five to about fifteen inches in height. If you don't have a swamp, you may grow it in a pot kept standing in a saucer of water. Another bog subject, far removed from the true grasses, is the horsetail, *Equisetum hyemale*. This is a jointed, hollow-stemmed fern ally, that attains a height of four feet. It is not a favorite of mine and is perhaps the most invasive plant I know of with a root system equal to reinforced concrete. Wind knocks it over, so plant it in sheltered locations. *E. scirpoides*, a diminutive form, is a delicate thing, almost like a magnified moss. Variegated forms are seen occasionally.

Phormum tenax variegatum, *New Zealand flax, is a cousin of agave and has been hybridized and selected into a veritable spectrum of color.*

Hermine Stover is co-owner with her husband, Roger, of Endangered Species, a California nursery that specializes in bamboos, ornamental grasses, phormiums, and other unusual offerings in the plant world. Originally from Boston, the Stovers moved to California and pledge they will never become a mega-nursery.

Leaping from the bog to New Zealand, we find the most colorful of the grasslike plants, the *Phormium* genus, commonly called New Zealand flax. This cousin of the agave has been hybridized and selected into a veritable spectrum of color. *Hortus Third* lists "probably two" species *(Phormium colensoi* and *P. tenax),* but they are available in great numbers ranging from small tufted plants to bushy clumps five feet tall or so. The colors include brilliant rose pink, peach, cream, clay green, a rich and bold maroon, scarlet, orange, yellow, and various striped combinations of all of these colors. They have fanciful cultivar names like 'Maori Maiden', 'Surfrider', 'Dusky Chief', 'Maori Sunrise', 'Sundowner', and 'Dazzler', the last a particular beauty that has magenta leaves striped in chocolate. It is seldom that one sees foliage so brightly colored as to rival flowers, but it is safe to say that the leaf coloring in some phormiums would strike some as gaudy.

Having flung about some of the brightest of colors, I must provide the ultimate in contrast, *Ophiopogon planiscapus nigrescens.* This is a tufted, narrow leafed plant of a color close to the purple black of typing carbon-paper. The bell-shaped flowers are hyacinth in color, and the fruits are translucent and look like amethyst glass beads. It is a member of a larger group of fake grasses which are actually lilies. The green form, *O. japonicus,* is considered a sod-forming plant, but if left to its own devices it will form lumps and humps, and overhang a curb in a way far more interesting than plain old sod. Another species, *O. jaburan,* comes in many kinds of yellow and white striped forms, for which the Japanese have a roster of cultivar names. These however, are grouped together in the United States.

Showy enough for pot culture and perhaps best appreciated that way, is *Imperata cylindrica rubra,* a green grass whose leaf tips are blood red. You don't see that kind of thing often.

Another larger group of true grasses is the genus *Festuca,* which has been cultivated for a long time and occurs in a range of colors and textures. Most of them form clumps of fine foliage, and the majority are strikingly bluish and quite hardy. They look good among rocks and as potted plants where their fine texture may be best admired.

I am very attracted to *Miscanthus sinensis* 'Zebrinus' (a grass of seven feet or so) because it has variegation in the form of horizontal bands, unusual in a monocot where striping is often parallel to the veining. This showy plant can look shaggy if it is not groomed. We chop ours to the ground yearly. There is also 'Variegatus' that exhibits parallel stripes of creamy yellow that run lengthwise on the leaf. This grass is an excellent tub subject, as containment lends a fountainlike form to the plant.

There is a rather rare non-grass bog plant called *Scirpus tabernaemontani zebrinus,* that has tubular stems of bright green, cross-banded in off-white. This plant flops over in a stiff breeze, but if I could grow only one bog plant in one perfect pot, it would be this! The stems are not jointed and quite fragile but the effect of the whole plant growing out of a mossy pot is unique and beautiful. It's an ideal terrarium subject.

From time to time somebody calls and says they have seen the most wonderful and gaily variegated bamboo ever, with white and pink stripes, growing wild somewhere and free for the digging. It always turns out to be *Arundo donax* 'Variegata', a plant I loathe from the disappointment of discovering that it is not a bamboo after all. However, it is a marvelous giant grass, and the new growth is rhubarb pink, fading into white margins on green leaves. It is a plant to be contained in a big tub, not only to give it form, but to keep it from invading the planet. Potbound, its coloring is perhaps more intense, and its form is that of a stately, erect fountain. In the ground it marches along resolutely, elbowing everything in sight. There is a solid green form which I dislike intensely.

If a person were so dedicated to variegation as to want an aggressive, variegated lawn, there is the following treat, the variegated St.

Augustine grass, *Stenotaphrum secundatum* 'Variegatum'. This grass, in its solid green form, is one of my least favorite plants. I understand one cannot play golf upon it as it is too lumpy. The variegated form grown as a pot plant with its extreme lemon yellow and bright green stripes, is a knockout. The idea of a lawn made out of this stuff is worse than a plaid blazer, striped shirt and paisley necktie, all worn simultaneously. That's how variegated it is and how assertive. It makes an excellent ground cover with larger potted plants, where you want just that proper touch of the vulgar.

There are a group of bamboos called *Sasa*. These are generally small, some less in height than a thick lawn, others easily maintained to under eight inches by a once-yearly shearing. The shearing also preserves the juvenile quality of this group of plants, thereby limiting the stem thickness to something like a toothpick, and also encouraging the growth of the new, beautifully marked, and colored foliage. These plants are unsurpassed as ground covers, wonderful as pot subjects, and perfect when used as bonsai companion plants as well as in dish gardens.

In a garden where walkways form an edge, these plants will not get away from you. In a less structured garden setting they should be restrained by subsoil barriers or grown in low containers. They count among their virtues an unsurpassed ability to hold the contours of steep terrain, and are able to prevent washouts of topsoil and the general unhinging of a three-dimensional landscape project.

Sasa (Sasaella) masasumiana albovariegata is one particular favorite. Its delicate stems are purplish, its foliage—which is slightly velvety—is strongly patterned in pale buttery stripes with a fine deep green pinstriping. In California, it is evergreen and plants are hardy to 0°F.

Years ago when I had but a single small clump I thought of it only as a pot plant, but now it grows outside the front door as an under planting for some giant timber bamboo, as well as in numerous tubs and pots. It is unusual to find such intense variegation that is not at the same time gaudy or overwhelming.

Perhaps the next best plant of this type is *Arundinaria variegata* which has mostly ivory leaves pinstriped in deepest green. It is said to grow to four feet in height, something I have never observed. I grow this in the ground as well as in small pots and large tubs, just to make sure I am surrounded by it.

A. viridistriata is another bamboo of small stature whose new growth is both velvety in texture and is colored chartreuse, striped with green. After a summer the foliage ripens into almost solid green, which is why a yearly shearing is such a good thing to do. This plant also grows outside the front door in pots.

All of these small ground cover bamboos give an unmistakable Japanese touch to a garden. If you could play golf on these plants, I am sure it would put the sod-forming grasses out of business.

I am certain that mowed lawns have their place in the realm of gardening, particularly in North America where gardens have inherited a formal British tradition. I like to see those tightly formed gardens with neatly shaped hedges and velvet lawns, but only from a great distance or in photographs, because I am too lazy to work at this sort of thing.

Which brings me round to the subject of *Dichondra micrantha*. This substitute for lawn grass is a member of the morning glory family—although you could have fooled me—and grows into a glorious green carpet that is as flat as a table and never needs mowing. Unfortunately it is only hardy in Zone 10. I believe one cannot walk upon it so one must use stepping stones in order to wander through it. It is the only lawn I truly like to look at, and, alas, it isn't even a grass.

It isn't possible to write about something as familiar and dear to gardeners as grasses without enraging someone by omitting a particular favorite. And I must admit that if most lawn grasses were never mowed but permitted to grow to their full height as in a meadow, I would have nothing against them. It's just the mowing that I hate!

A GREAT SCALE FOR GRASSES

We tend to think of gardens and the plants they contain in terms more private than public. Wolfgang Oehme and James van Sweden have other ideas. The following article presents their views on ornamental grasses and designing gardens on a public scale. But their ideas work just as well in that small garden.

—P.L.

Wolfgang Oehme and James van Sweden

All of us spend as much time living in the community as we do in our homes. Yet we are surrounded in our cities by foolproof evergreen landscapes that are, as Christopher Lloyd says: ". . . a kind of living death." Such gardens could be revived with only one significant accommodation—by changing their viewpoint from a private to a public scale. Most of our firm's design concepts deal with space, whether for a layered effect, a four-seasons garden, or the sheer dynamism of plants. In fact, we believe that even intimacy belongs in the city and put plant combinations together on the biggest of sites just as we do on the smallest. By looking at the Federal Reserve garden in Washington, D.C., for example, people could learn about design for their own gardens.

What would you be looking for if you walked into one of our public gardens? First, you would check for balance. Are the evergreens and the deciduous plants in the correct proportion? In general, our garden designs are one-third evergreen. This approach is especially valuable in the winter when they are useful as backdrop to the dried ornamental grasses and their seed heads. They also define space, creating permanent layers of contrast for the changing layers of herbaceous plants, providing the deciduous effect that is so important on a large scale when summer lushness gives way to winter's elegant structures.

How interesting is the garden in every season? The public garden is on stage every day of the year and should always try to attract the passer-by. This is perhaps the most difficult aspect of design. Like choreographing a ballet, we try to visualize the design as moving across the palette of an entire year.

How are textures used to express the tactile character that is a central proposition of such gardens? In composition, the textures make a touchable structure of their own that ranges from the bold, upright sculpture of a yucca to the subtle flowers of the pendulous soft pennisetums to *Coreopsis* 'Moonbeam' with its finely cut leaves. Textural contrasts are even more important than color. We use it in bold, amorphous "cloud" masses to bring richness and focus to the design.

These three principles—balance, interest, and texture—are what make a garden. They help to create a personal scale that relates to nature. People go out to the garden to have

Wolfgang Oehme and James van Sweden are the owners of a Washington-based landscape-architect firm that has been the leading exponent of using ornamental grasses both in the home and in the commercial garden.

Pennisetum setaceum, *fountain grass, is a lovely grass with attractive flowers and a graceful, arching form.* *Drawing by Peter Loewer*

lunch and relax, to meet someone and talk; they need a comfortable place to sit. We try to bring the scale of the city to a more personal level so that everyone will have a smaller space to anchor themselves, all amid the hustle and bustle about them. People can sit surrounded by plants and ornamental grasses and yet not feel hemmed in.

All of our designs are organized as a series of layered spaces that become progressively less architectural as they move out from a building. In public situations, we often plant trees well away from the building to create inner and outer areas. From more private spaces next to the building, the street view is softened; while from the street, screening layers create a scene worth exploring. Passers-by will discover interlocking volumes of planted and open spaces, boldly defined in a hurried city.

Boldness is the major difference to residential design, for the public garden must be "readable" at higher speeds and greater distances. Driving by, an undulating line of planting sweeps to the edge of the street, then dives deep into the garden, catching the eye like a fish on a hook. The garden should be dramatic when it's passed at 35 to 40 mph and it should also be beautiful from above. Our approach is to simplify the planting plan, using a smaller plant list in much bigger blocks of space for clarity and contrast.

On Pennsylvania Avenue we have relied, as usual, on a tough and disease-resistant planting list that doesn't call for a lot of maintenance. Such low maintenance must be a viable concept for gardens if we are to achieve a public landscape that is humane. Ornamental grasses grow in clumps that may need division about once in a decade but continue to maintain their scale without the help of pruning shears. With automated irrigation (every other night), and a feeding program, the ornamental grasses, perennials, shrubs and trees grow quickly and well. This is planned maintenance, an important part of a landscape architect's services.

Our firm has a long-term contract with the Pennsylvania Avenue Development Corporation to walk the avenue every week, noting problems and making suggestions. This is, of course, an ideal situation, but we always write a maintenance schedule for our projects—plant by plant and month by month—so that the maintenance staff can see exactly what they should do in every plant season. They won't cut down the beautiful winter garden in November; they'll feed each plant properly and allow it to develop naturally into its fullest form. It only takes one cycle for the staff to feel comfortable: it's a change in attitude and everyone stops hacking everything into shapes of balls and boxes. There are two big pluses to such plantings that impress maintenance people: ornamental grasses repel dogs and especially rats, whose burrows are invaded by the roots and people are less inclined to steal plants that look so natural in their settings.

Thirteen years ago, on the first public job for the firm, Jim asked Wolfgang what would happen when the rudbeckia grows into the pennisetum and tries to take over. Wolfgang answered: "They will fight it out!" And they did, calling it a draw. These plants develop at the same rate, both have vigorous root systems, and they tend to be so dense they crowd the weeds out, and they are also mulched well. Sometimes a black-eyed Susan peeks out from the pennisetums, making it all look like the blurred margins of a meadow.

Many urban sites aren't actually on the ground, but built over underground garages and on rooftops where the garden must be "built" over a sublevel structure. The Federal Reserve garden is such a place and demonstrates the wealth of plant life that's possible in light, shallow soil that is well fertilized, watered, and has good drainage.

Lately, we're more and more interested in combinations that explore how ornamental grasses, when used in large scale designs, become exclamation points or living sculptures separated from other masses of material on the ground plane. We have been

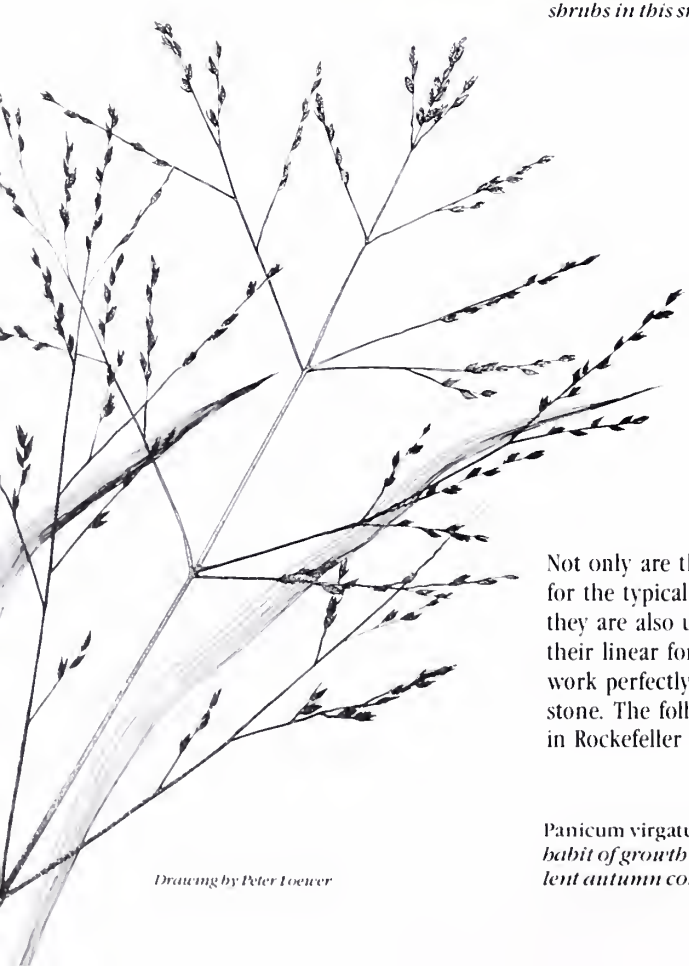
inspired by Frank Stella in the design of a waterfront park in New York City, a jazzy score with great mounds of *Miscanthus strictus* used like staccato dots of gold. It's an effort to start a garden movement that reclaims the public landscape for the people—and we think it's about time.

Brooklyn Botanic Garden's monocot border contains (left to right) Miscanthus sinensis *'Gracillimus' and* Erianthus ravennae.

Photo by Elvin McDonald

Photo by Linda Yang

Rushes are combined with hostas, irises and shrubs in this small city garden.



Drawing by Peter Loewer

Not only are the ornamental grasses perfect for the typical suburban or country garden, they are also useful in city gardens where their linear forms and feathery flowers work perfectly against masses of metal and stone. The following is about grasses used in Rockefeller Center. —P.L.

Panicum virgatum, *switch grass, has an upright habit of growth that is light and airy and excellent autumn color.*

Grasses in the City

Photo by Edwina von Gal

A display of grasses was installed at the Channel Garden at Rockefeller Center several years ago. The plants were grown especially for the display.

Linda Yang

The plantings seem natural enough—clumps of towering grasses which wave and rustle in the breeze. Yet this is no marshy seaside setting. Instead, these slender stems in tones of blue, gold, red and green, are a featured display at the Channel Garden in Rockefeller Center, where the wind that bends them to the pavement sweeps in between the Fifth Avenue skyscrapers.

The grasses were scheduled to remain in place for a number of weeks "depending on how they hold up," said Carl Miller, vice president of Rockefeller Center's Management Corporation, which oversees the dozen different landscape designs installed there each year. "If the grasses break or bend too much, our winter evergreens will be brought in to take their place."

The idea for a show of ornamental grasses was suggested to Mr. Miller by Edwina von Gal, a New York City landscape designer who said she first became fascinated with the plants after seeing them in a nursery field. Particularly effective in her design for the Channel Garden, are the scattered groups of tall, wheat-toned *Miscanthus sinensis*, which includes such cultivars as 'November Sunset', 'Silver Feather', and 'Silver Arrow'.

The grasses—which attract a lot of small city birds—are particularly beautiful at night, said Ms. von Gal.

The miscanthus grasses (*Miscanthus* spp.) are surrounded with plants of contrasting colors including the purple-plumed pennisetums *(Pennisetum setaceum)*, the blue-toned wild rye *(Elymus glaucus)* along with the low growing variegated ribbon grass *(Phalaris arundinacea picta)*, with its cool green and white stripes. There are also blue fescues (*Festuca* spp.), the golden-hued variegated Japanese sedge (*Carex morrowii* 'Old Gold') and the crimson-leaved Japanese blood grass *(Imperata cylindrica rubra)*. Then when the Center's lights touch them they give an impression of an early winter sunset.

All of the plants in the display are hardy when used in the New York City area of USDA Zone of 7a with the exception of the stands of pampas grass *(Cortaderia selloana)*. "If you have sun," she said, "they are all wonderful for the garden and they also tolerate moist, poorly drained soils."

The containers in which the grasses have been planted vary in depth between 18 and 20 inches, according to David Murbach, Rockefeller Center's division manager for gardening. This is the minimum size that terrace gardeners should use. The plants were grown especially for this display by Kurt Bluemel at his nursery in Maryland. They were balled and burlaped at the nursery and delivered to the city by truck.

All the plants in the Channel Garden are watered with cooled steam condensed from the air conditioners of Rockefeller Center. As a result they have received a commendation from the Environmental Action Coalition for helping to keep the city green.

Linda Yang is the author of the Terrace Gardener's Handbook, *a contributing writer to* The New York Times Home Section, *a photographer, and an expert at city gardening.*

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Of Grasses

The following excerpt is from *The Book of Grasses* by Mary Evans Francis, published by Doubleday, Page & Company in 1912. It is a lovely book that deals with the beauty of most of the common American grasses and many of the sedges and rushes found from Canada southward to Virginia, and from the Atlantic coast westward to the Mississippi River. —P.L.

Mary Evans Francis

From spring until late autumn grasses bloom by every wayside, and in field and meadow to form the green carpet of the earth. Widely distributed throughout all countries, and abundant even in faraway prehistoric days, grasses remain the most important family of the vegetable kingdom, and—of all common plants the most common—the least commonly known. Yet from the moment when the first violet lifts its blossom to the sunlight until in autumn the witch-hazel's delicate flowers are seen above fast-falling leaves, there is never a day when grasses are not in bloom, and never a week in summer when a score of different species may not be gathered.

In richness and variety of coloring, above their undertone of green, the blossoms and wind-blown anthers of the grasses rival in beauty the flowers that the wayfaring man collects. The grace of swaying stem and drooping leaf, the delicacy of tiny flowers tinged in rose and purple, and the infinite variety shown in form and coloring are lost upon those who are intent on seeking flowers that the forests make rare. Grasses there are, stout and higher than one's head, and grasses so slender that their dying stems among wayside weeds are like threads of gold; grasses whose panicles of bloom are more than half a yard in length, and of a color which only a midsummer sun can burn into August fields; grasses so stiff that winter's snow leaves them unbroken, and grasses so tiny that their highest flower is raised but a few inches from the soil.

Nearly one thousand species are found in the United States, nor is the study of these plants so difficult as it is thought to be. When accuracy in determining the individual species is desired, a small microscope and a few needles for dissecting the blossoms are all that is necessary. Even without these aids an intimate acquaintance with the grasses may be gained by observing only their most obvious characteristics of growth, and the various forms of flowering heads. Notice closely the grasses in a low meadow of early summer: the dense growth of green, hastily characterized as "grass," may contain many different species of this vast family, species which at a second glance are seen to have each their own distinguishing features.

Like charity the study of grasses may begin at home, and, like charity also, this most fascinating of nature studies may be carried far afield, for the grasses, most numerous of all flowering plants, we have always with us. Tree-like in the tropics the bamboos, largest of the grass family, lift their blossoms 100 feet and more toward the sky; in cold countries moss-like grasses cringe and cling to the frozen ground, and through the temperate regions of

Mary Evans Francis is the author of The Book of Grasses, *published by Doubleday, Page & Company in 1912. It is one of the beautiful books on horticulture and nature that Doubleday published in the early 1900s.*

Miscanthus sinensis *'Variegatus' planted in a mixed border at Longwood Gardens.*

the globe grasses grow in luxuriance of form and coloring and supply a background of green against which the world of trees and rivers, of brooks and ledges, is placed on colors ever changing, and ever perfect. Nature is continually busy reclaiming the unsightly places abandoned by man, covering with a garment of green the hillsides torn by rain, and carpeting with her "matted miracles of grass" the humble waysides.

The traditional spirit of the seasons is symbolized by outdoor coloring: cool, pale tints of early spring, rose color of June, warm tones of August fields, and a glory of purple and gold when the summer is past and the harvest ending. In all this continuity of change, which keeps the fact of Nature so new in its world-old familiarity, the grasses bear their part, and

Eragrostis spectabilis, *purple love grass, grows naturally in dry fields. It has a very large inflorescence for such a diminutive plant.*

as the violet and wild geranium of spring give place to midsummer hardhack, which in turn is pushed aside by goldenrod and asters, so the passing months bring fresh grasses into bloom and mark the calendar of the year by the flowering of these common plants.

It still is true, however, that:

"The world misprizes the too-freely offered
And rates the earth and sky but carelessly."

Drawing by Peter Loewer

Photo by Peter Loewer

Japanese blood grass (Imperata cylindrica rubra) *grows to a height of 18 inches and a breadth of 12 inches. It contrasts nicely with* Carex morrowii *which has gracefully arched leaves striped with creamy white. Both grasses stand out when light shines through their leaves.*

Photo by Elvin McDonald

Celosia in the foreground is backed by large clumps of a Miscanthus sinensis *cultivar. The grasses make a bold statement visually dividing the open space.*

Photo by Pamela Harper

Left: *Many ornamental grasses are most effective when used with a massed planting of a single perennial species. Here* Rudbeckia fulgida *is effectively combined with* Miscanthus sinensis *'Variegatus'.*

Below: Molina caerulea, *purple moor grass, produces a fountain of rigid leaves. The panicles occur atop curving stems that reach three feet in height. There is a handsome variegated form.*

Photo by Peter Loewer

Photo by Peter Loewer

Bottom: *A garden of grasses assumes a different aspect in the autumn. Colors have changed and seed heads have developed. If left standing, these grasses will add contrast when snow covers the ground.*

The dandelion is less honored than the arbutus, yet even the dandelion receives greater honor than do the early grasses, which aid in changing earth's wintry shroud to living green. Grasses yield us the earliest intimations of spring, as a faint flush of green, in harmony with the soft colors of April woods, tinges the brown hillsides before snows have ceased. The first grasses are more delicately colored than are those of midsummer when the sun burns red and purple into the tiny flowers. The green spikelets of many spring grasses depend for color upon their lightly poised anthers of lavender and gold. Sweet vernal grass, orchard grass, and june grass, so characteristic of spring, are succeeded by spreading panicles of hair grass, bayonetlike spikes of timothy and the richly colored red top whose blossoms burn with midsummer's warmth. September has still new grasses to offer, and in this month the beard grasses are conspicuous, as their stiff stems at last attain a growth that will enable them to withstand snow and frost. In many localities from 50 to 100 different grasses may be gathered, and, although, unlike the lilies, they do not flaunt their colors garishly, yet in rose and lavender, in purple and an infinite scale of green they rest and charm the eye with their beauty from April to October, when frosts bring to them new hues of brown and yellow in which they clothe the earth until green blades again push through spring turf.

Our waysides are the accepted gardens of many plants which, having followed the path of mankind through the New World, take the highways of civilization for their own, and find abundant means for transportation as seed is fastened on passers-by, or carried by the wind along smooth pathways. Few are the grasses that cannot be found in these wayside gardens as the roads wind through fertile country, from uplands to rich meadows, or pass sandy shores, where in a variety of soils the different grasses bloom and add a mass of verdure to the border of the way. Throughout the season these common gardens of the wayside hold a constantly changing procession of grasses; a procession which begins with low spear grass and sweet vernal grass in April, and ends in October with the dropseed grasses and the beard grasses, although even in winter the species that remain standing may still be recognized.

Rarer flowers must be sought in deep woods and in hidden places in the swamps, but the cosmopolitan grasses are fitted to take up the struggle for existence wherever the seed chances to fall. Dean Herbert rightly says that "plants do not grow where they like best but where other plants will let them." By waysides we may see this struggle in its intensity as a dozen species strive for the same plot of ground and grow in tangles that include low cinquefoil and tall briars. The strife is always most intense between individuals of the same species, and here the grasses grow in profusion, occupying each inch of space, pushing out into deserted country roads, and spreading far and wide by means as interesting as ever the more noted flowering plants employ.

Bur-grass, with its thorny seed-burs, catches on passing objects and thus secures free portage to new fields; terrell-grass by thick, corky scales floats its seed upon the streams near which it grows; beach grass defines the sand to bury it and is found at the tops of the highest sand dunes, with whose rise it has kept pace, the long roots of the grass penetrating to the base of the dune; and couch-grass, sending sharp-pointed rootstocks rapidly through the soil, is a veritable "land-grabber."

Where the purslane and poppy produce a multitude of seeds from every flower, each blossom of the grass ripens but one, yet so richly stored is this with nutriment, and frequently so well protected against germination under unfavorable conditions, that the one seed may be worth many of those less perfectly equipped, since, in the process of evolution, diminution in the number of seeds is accompanied by an increase in the effectiveness of those that remain.

The twisted awns of certain grasses—e. g., sweet vernal grass and wild oats—show one of the most interesting mechanisms seen in the vegetable world. These awns, or bristlelike

appendages of the grass flower, are extremely sensitive to atmospheric changes, and by their peculiar structure aid in burying the seed beneath the surface of the soil. In sweet vernal grass the scale, to which the ripened seed adheres, bears a brown awn, bent and twisted near its middle, and beset with minute, upward-pointing hairs on its basal part. Such awns are strongly hygroscopic and during cold or dry weather remain tightly twisted, thus holding the seed where it chances to be. Under the influence of moisture the awn untwists and by its rotation drives the fallen seed slowly but surely beneath the soil. Although dry weather may follow, causing the awn to became twisted again, the upward-pointing hairs catch on particles of earth or grass and, holding the seed down, prevent it from being drawn up. Thus it lies ready for the next shower when the awn pushes the seed farther into the earth. This peculiarity of structure is easily observed without the aid of the microscope. If a few of the ripened seeds are laid upon the moistened palm of the hand they will immediately begin to move, as if alive, and the rotating of the awn can be plainly seen. Interesting experiments have been made whereby it has been seen that in sand, alternately wet and dried, the awns of certain grasses will bury the seed several inches beneath the surface.

Each locality shows characteristic grasses, and as in a short walk we pass from low meadows to dry hillsides we find new species to excite fresh interest. On sea beaches we look for the long, gray-green leaves of marram grass, or beach grass, for spreading clumps of sea-beach panic grass, for the dark, wiry stems of fox grass, and for rigid-leaved grasses of hot sands. Salt marshes show dense jungles of reedlike grasses, creek sedge, salt reed grass, and the tall reed. Dry hillsides are covered in spring by wild oat grass and wavy hair grass, where later purple finger grass sheathed rush grass, and stiff beard grasses will bloom. In dry fields we look for the low growth of the smaller panic grasses, for the slender, one-sided spikes of field paspalum, and for wide-spreading panicles of purple eragrostis. Borders of woodlands offer poverty grass, black oat grass, and muhlenbergias, while in deep woods we search for shade-loving grasses, the tall, slender bottlebrush grass, the lower mountain rice, and the nodding fescue. Marshy meadows are full of interest to the student of grasses: reed canary grass with broad, blue-green leaves borders narrow brooks, and nearby the blue-joint grass, slender and stiff, rises bearing narrow, deeply colored panicles; graceful manna grasses fill the marshes of early summer, and later the rough leaves and stems of rice cut grass form tangled masses in low grounds. By river borders grows the great grama grass whose leaves are so broad as to resemble those of our cultivated corn, and in wet soil, also, is found the tall Indian rice on which the reed-bird feeds. A country dooryard of an acre may show more than a dozen different grasses, while in the garden near half a score of other species invade the cultivated land and weeds. A large collection of grasses, preserved either as herbarium specimens or in the more artistic impression made upon photographic paper, may be gathered in a short time, and differences perhaps little noticed by the casual observer will seem marked indeed to the student who at the close of a summer's study will deem it as unpardonable to mistake one of our commom grasses for another as to mistake an elm for an oak.

Corn, wheat, oats, the day of the first cultivation of these cereal grains long antedates history, and how seldom is it realized that they are grasses. Virgil and Columella wrote long ago of the care of meadows and fields. Indeed the word cereal stands as an article of faith in the goddess Ceres, who searched with torches for the grain carried off by winter frost, and on finding the seed raised it to its flower once more. Bertha was the Ceres of German mythology, and winds and rains affecting crops were believed to be under her control. Corn spirits there were which were symbolized under the forms of wolves and goat-legged creatures, similar to classic satyrs. To the older peasantry of Germany and Russia these corn spirits still haunt and protect the fields which show the "Grass wolf" or "Corn wolf" to be abroad when the wind, as it passes, bends the grass and the ripening grain. The last sheaf of rye is occasionally left afield as shelter for the "Roggenwolf," or "Rye wolf," and it is not long since the Iceland farmer guarded the grass

around his fields lest the mischievous elves, hiding among the grasses, and ever waiting to harm him, should invade his cultivated land.

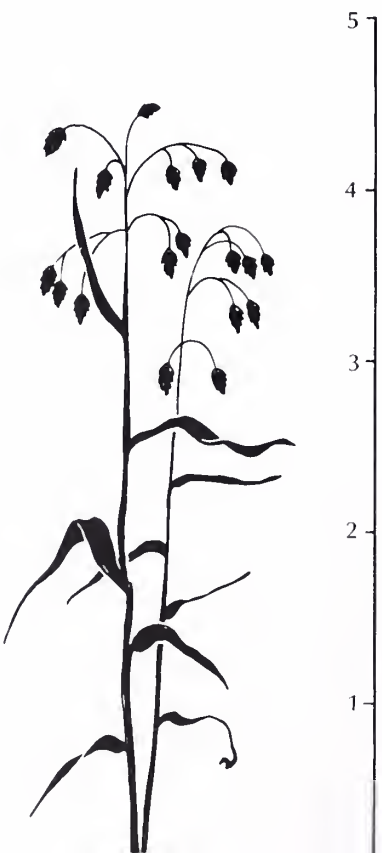
In old herbals the word *grass, gres, gyrs* meant any green plant of small size, and though we have restricted the meaning of the word it still is carelessly applied to a multitude of sedges and rushes which in manner of growth and form of flower differ markedly from the true grasses. To the casual observer the grasses are but "grass," and to few is their diversity, their beauty, and their value apparent. We are blind to the infinite variety shown by nature in these common plants, of which we often know scarcely more than do the cattle that feed upon them; yet on no other family of flowering plants does the beauty of the green earth and its adaptation as a home for man so largely depend.

Alopecurus pratensis, *meadow foxtail, is planted along a fence in Longwood Gardens' Idea Garden. It is one of the easiest of grasses to grow. Also available in many variegated forms.*

Photo by Elvin McDonald

Ornamental Grasses in the Rock Garden

The following articles both deal with grasses for the rock garden. Mr. Myers points out that even the rock garden purist has something to learn from growing grasses, and Dr. Nixon hastens to add more grasses to that fire. It is interesting to note that together they speak of 27 different grasses and only overlap on two choices, *Eleocharis parbula* and *Hakonechloa macra* 'Aureola', both of those grasses being particularly beautiful. —P.L.



Drawing by Peter Loewer

Louis Budd Myers

At a recent rock garden lecture, the speaker, with a tone that suggested a raised eyebrow, stated that he had heard of some people who are growing *grasses* in their rock gardens. It is true that rock gardening has its purists and has come to mean, among other things, the attempt to grow the difficult flowering plants of alpine regions, but rock gardening can mean also having a good time and creating settings that please the eye. Some easier-to-grow plants are a blessing.

A friend, many years ago, told me that sempervivums are the binder that hold the rock garden together. He was referring to their many uses: to conceal cracks between rocks, to hold back edging soils, as well as to be decorative. I find that some grasses work in a similar way. Other grasses are beautiful enough to be used as accents. I have chosen 12 grasses that I enjoy above all others.

Louis Budd Myers is a well-known rock gardener. He was for thirty-three years an editor and writer on the staff of a national biographical encyclopedia and has contributed many articles to the American Rock Garden Society, The Conifer Society *and other scholarly journals.*

Chasmanthium latifolium *(left), northern sea oats, is about two feet high with large flattened seed heads rising above the leaves. It is often cut for dried bouquets.*

Right: Hakonechloa macra *"Aureola" is striped with vibrant yellow and green—the blade edges are suffused with rosy pink.*

Bouteloua gracilis (blue grama) a type of forage grass of the prairies, has several appealing features. Its flowering heads rise about 20 inches from a dense tuft of grayish green, fine leaves that twist about in a curly tangle. The heads grow at almost a right angle to the stem. They look like lacerated flags, each with a fringe of purplish stamens hanging in a row. After ripening each resembles a row of eyelashes. The stems dart here and there, winking in the wind. *Bouteloua* is distinctly graceful and enhances an open alpine lawn. Individual plants of lower stature can be found.

Carex comans is one of the two New Zealand natives to survive in my Poconos rock garden, the other being *Geranium sessiliflorum nigrum.* Both are brown-leafed plants. This carex also has a green form, but the brown form comes true from seed. This form always fosters the illusion of fall or winter for most onlookers. Its foliage is tannish brown deepening to rusty-orange tones toward the base. Its innumerable leaf blades fountain out from the base and are more than a foot long. It is a mistake to cut back the foliage at any time since the plant is evergreen (ever brown?) and the cut basal stems never wholly disappear. The plant is decorative anywhere that one wants a soft accent. It looks particularly good against gray stone. Its flowering stems are strangely attenuated, each much longer than the leaf blades. A stem appears to reach out and almost plant its seed heads in the soil. I have found few seedlings.

Carex plantaginea, a native plant, prefers moisture and some shade. It is one of the first plants that was introduced into my childhood rock garden. I found it fascinating and unique because of the rippling or puckering of the leaf between leaf veins, an effect that resembles seersucker. It can form a carpet if the soil is rich and loamy, but it can be kept to a single plant with diligence. The leaf blades can reach some 10 inches in length. Its inflorescence is insignificant, although brightly spiky with yellowed stamens.

Chasmanthium latifolium, (Uniola

Drawing by Peter Loewer

Chasmanthium latifolium

latifolia) a common and longtime favorite of American gardeners, is called northern sea oats or wild oats. About two feet tall, it has grasslike basal blades which are slightly glaucous. Its large, flattened oatlike seed heads, suspended on thin arching stems, flutter and twist in the slightest breeze. The movement is so refreshing that the plant should be in every garden. It will take a lot of shade and likes a woodland setting. It is best known for its use in dried winter bouquets.

Dactylis glomerata variegata, which is striped white and a pale green, would appear to come in various forms. The one that I grow stays diminutive. It was planted on the edge of a nest of sempervivums on the lower reaches of a scree bed. As both plants have multiplied, the *Dactylis* has come to pop up in low tufts here and there among the "semps." Recently *Ephedra minuta,* a small gymnosperm, has begun to invade the bed, and the result is delightful. *Dactylis* is easily removed from scree. I would be very careful about planting it in any other type of soil mix unless measures were taken to keep in confined.

Eleocharis parvula is tiny and easily overlooked. It grows on the moist verge of the small rock garden bog. After many years it has formed a clump some three inches across. A sedge, it is a very close relative of the Chinese water chestnut. Each hairlike spikelet is about an inch long. Its name is derived from the Greek words meaning marsh and grace. It is widely distributed. A wallower in bog heaven, it comes from the edges of muddy ponds.

Hakonechloa macra 'Aureola', a native of Japan is an outrageous beauty. Although Hakonechloa is a difficult name to master, in Japan it is known as Urahagusa Zoku. It grows on wet rock cliffs in mountains but is amenable to a variety of garden conditions. Its overall beauty: coloration, form, and mobility in a breeze, is paramount. *H. m.* 'Aureola' is striped with a vibrant yellow and a pleasant green and each leaf-blade edge becomes suffused with rosy pink. Rainbow or peacock grass would make apt common names. It mul-

tiplies quite rapidly by stolons but is not rampant. A small beginning clump may become a foot or more across at the base in a few years; the arching leaf blades make the clump appear to be almost twice that size across. Each six- to-eight-inch leaf blade comes from a stem that has slightly thickened nodes at the axil and resembles bamboo. This grass should be planted in a special place, perhaps against a background of dwarf evergreens, somewhere in a niche of its own.

Juncus mertensianus also graces the rock garden bog and must be watched diligently or potted in a container which has been sunk in the bog. If one has a large bog or a poolside for planting, it need not be restrained so forcibly. Although it has the usual rushlike leaf spikes, its seed head is elegant—quite large and purplish black, not unlike a flattened, shiny, black raspberry. It is 10 inches or less in height.

Luzula spicata, an alpine or subalpine rush, does not look like a rush. It forms a caespitose heap of slightly falcate, or curved hairy basal leaves. The hairs of this attractive plant lend a silvery sheen. *Luzula* can be used wherever the soil is slightly dry, acid and the site is shady.

Panicum clandestinum, the corn or deer's-tongue grass, forms large, dense clumps. Like many panic grasses, its broad leaves taper to a point and project at intervals up the stem. It must be placed carefully in the rock garden, because of its height which can reach three feet. I cut back my plant in midsummer—the subsequent growth is shorter and more dense. The late fall coloring of this grass, at least in my garden, is magnificent—leaves smeared a deep, vibrant claret with tan and green patches. The color persists long after the leaves are cut for bouquets.

Stenophyllus capillaris, a true annual and the only member of this genus, is a spiky hedgehog of rigid looking hairlike stems. The plants vary in size, from minute to eight inches in height and width, depending on the soil. Those that seed in a trough in my garden stay tiny. The grass can seed anywhere but is so easily removed that it poses no threat.

Stipa tenuifolia, an annual in my garden, is exceptionally beautiful. Another fountaining type, this grass has numerous hairlike,

Photo by Elvin McDonald

This photograph shows the graceful habit of Hakonechloa macra *'Aureola'. It contrasts nicely with the dark green leaves of hosta, annuals and other perennials.*

one-foot-long leaf blades on each plant. Aside from its soft, airy quality, *Stipa tenuifolia* is a pleasing light green color, an apple green, quite unlike anything else in the garden. Everyone is attracted by it.

With the passing of years certain grass clumps expand beyond the accepted confines. I recently established a rock garden of grasses, a bed dominated by a large rock. In this new garden I have planted the garden overflow and have added certain other taller and more invasive grasses that are not suited to the older garden. The grasses, brought together in this way, in all sizes and colorations, are a new delight. Examples remain in the established rock garden as small specimens.

Some Grasses for the Rock Garden

Photo by Elvin McDonald

Dr. C. William Nixon

There are literally hundreds of grasses that have potential as rock garden subjects. Fortunately, there are criteria that, if applied, limit the scope.

The criteria I have used to narrow the field comprise the following:

Size of Grass: The grass *must* be of a size that is small enough to fit into most rock gardens or smaller still for a trough planting.

Uniqueness: The grass should be different in some way.

Form: Size and uniqueness along with the shape or growth habit combine to give the plant's "form" which is important in judging the suitability of a grass as a rock garden subject.

Habit of Increase: Grasses can be invasive from both seed dispersal and stolons. Stolons are usually underground and often go undetected until it is too late. On the other hand, there are grasses that utilize these same methods of increase but not to such excess that they become pests. And then there are a few grasses that are so difficult to grow that this can become a negative factor.

Color: In addition to the shades of green, grasses come in other colors and combinations. There are those with red, yellow, gold or white, often in various combinations with green or, sometimes, entirely of a color other than green. These colors are important in the positioning or placement of a grass. For instance, white (or even gold or yellow) will show up best with a dark background and, happily, a dark corner may be significantly brightened by these same grasses. Also, included here are the hirsute and woolly grasses as these characteristics can impart a gray color to what would otherwise be a green plant.

Personal Preference: A subjective criterion but an important one.

The Grasses

Alopecurus lanatus (woolly foxtail grass) is very difficult to grow. It is mentioned because it is a densely woolly (and therefore gray in color) grass. Originating in the mountains of Spain, it is probably not winter hardy throughout much of the United States and should be grown in a trough that can be moved to an alpine house or cold frame in winter. By doing this, it will also keep the winter wet off the woolly leaves and crown, another requirement for this touchy plant. Grow it in extremely gritty soil with a generous amount of chippings around the crown. It grows only to about four inches high and is a very slow grower.

Arrhenatherum elatius bulbosum 'Variegatum' (bulbous oat grass) is a very attractive and striking grass, but the *only* form of the species worth growing. Usually attaining a height of about a foot, this plant has narrow white-striped leaves. It is easy to grow, and, if it has any fault, it is that it can spread rather rapidly by means of bulbils that form at the base. These fall off and root. Grow in full sun and a lean soil mixture to keep it in bounds. Hardy to Zone 5 at least.

Deschampsia flexuosa 'Aura' (yellow wavy hair grass). This is the yellow form of wavy hair grass and is far more attractive than the normal green plant. The yellow form was discovered a few years ago in the mountains of Czechoslovakia and named 'Aura'. You will likely find it called 'Aurea'. My plants have never grown over a foot in height. They form dense clumps of very fine leaves that remain during the winter. It prefers acid soil and seems to be happy in sun or shade. This form, 'Aura,' comes true from seed, and it may also

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Dr. C. William Nixon is the founder, editor and publisher of the Sempervivum Fanciers Association Newsletter, *the author of a number of scientific articles, a research consultant in animal genetics and a general all-around plantsman.*

Festuca ovina glauca, *blue fescue, is the bluest of all grasses and one of the finest for rock gardens. There are many named cultivars from which to select.*

be propagated by division of the clump. Hardiness should be no problem.

Eleocharis parvula (spike rush) is a dwarf sedge. It grows to one inch in height and prefers wet feet (It will even grow under water!). This tiny plant is obviously a good subject for a wet trough or a boggy area. It is attractive and quickly forms lovely green mats when in a desirable location. It may invade moist areas and should be watched carefully. Hardy to Zone 5.

Equisetum scirpoides and *E. scirpoides* 'Curly' (dwarf horsetail), the smallest species of *Equisetum*, grow only four to six inches high. Plants of this species must be kept constantly moist, and like most horsetails, can be invasive when in the right conditions. *E. scirpoides* is a tiny and attractive plant whose hollow stems stand straight up. However, the 'Curly' form is even nicer as the stems are contorted and wavy, tending to go in all directions. Consequently, 'Curly' is not quite as tall as the type plant. Hardy to Zone 5.

Festuca ovina var. *glauca* (blue fescue) is one of the best grasses for the rock garden. It is the bluest of all grasses and one of the finest. There are many named cultivars of slightly different sizes and degrees of blueness—all worth growing. This is a perennial evergreen grass usually attaining somewhere between 6 and 12 inches in height, and hardy to Zone 4. It requires full sun and perfect drainage. Give it a gravelly sandy soil. The leaves are blue, slender, stiff, and spiky. The plant grows naturally as a tight clump that slowly increases its size and is non-invasive. Increase it by dividing the clump. Although self-sown seedlings are often found, they may vary considerably from the parent in size and degree of blueness. However, they are almost always attractive and garden worthy. Unfortunately, plants sold under this name are often something else.

Hakonechloa macra 'Aureola' is one of the most strikingly colorful grasses. The leaves are flat, narrow and graceful, and tend to arch in the same direction giving the impression that the wind is blowing. This is an added attraction, and careful attention is advised when situating it. The precise leaf color is almost indescribable. Each leaf is irregularly streaked lengthwise with green and cream-yellow. In good light, much of the leaf turns pink or even bronze. However, this grass prefers some shade. Grow it in a rich, well-drained compost with no lime. It reaches a height of 12 to 24 inches. Propagate by dividing the clump since it spreads slowly and non-invasively by underground stolons. This is a lovely plant and is hardy to Zone 4.

Holcus mollis 'Albovariegatus' (white variegated velvet grass) is the best small variegated grass, a deciduous perennial, growing only to about four inches. A broad pure white stripe runs on both edges of the leaf with a narrow green stripe running down the center. When happy, it produces many long underground rhizomes and can spread rather quickly, but it is worth the problems it might cause. The typical non-variegated plant, *H. mollis*, is a terribly invasive weed and has no garden merit. Fortunately, 'Albovariegatus' is more restrained and far more attractive. Hardy to Zone 5.

Imperata cylindrica 'Rubra' (Japanese bloodgrass) is a lovely medium-size grass. It was not supposed to be winter hardy so in the early years it was wintered in a cold frame or indoors. As it became more abundant, many of us began leaving clumps outdoors in winter and, although it was completely deciduous, it reappeared in spring. From personal experience, I know that is has survived in Zone 5 to 6. The clump increases rather slowly. The leaf blades are green at the base but turn blood red at the ends of all the leaves. This grass is most spectacular if placed where the evening sun is behind it, causing the red leaves to glow. Propagate by dividing the clump.

Lagurus ovatus 'Nanus' (dwarf hare's tail grass). The 'Nanus' form, an annual, is a miniature version six inches or less of the larger *L. ovatus* which may reach two feet. Plant the seed in spring where the plant is to grow, and it will produce its lovely inflorescences in late summer. The foliage is

unremarkable but its many flower or seed heads look like little rabbits' tails. It makes the best show if grown in bunches or patches. It is a choice small grass, but the seed may be difficult to locate.

Mibora minima (early sand grass) is a tiny annual grass that grows to a four-inch maximum and usually less. If happy, it produces seeds quite heavily. The tiny plants appear early in the growing season and quickly reach maturity. By early summer, it is in flower, seeds promptly, and then usually dies. Where it is moist, it may remain green for a longer time. Although this plant seeds itself, it has a shallow root system making it easy to pull out. It makes neat little tuffets, with tiny, hairlike leaves that are wiry. This is also a useful plant for troughs where the little clumps impart a natural turf appearance. It seems to prefer to grow in rocky or gravelly soil.

Milium effusum aureum (Bowles' golden grass) is an extremely showy grass and easy to grow. It attains a height of about a foot and has rather broad leaves that are a glowing golden yellow. The intensity of color varies during the season but is most vivid in spring. Depending on the severity of the winter, the leaves may not die back. Trim back in early spring before growth begins, since the new leaves are the most brilliant. It is hardy to at least Zone 5 to 6. This plant comes true from seed, and, if one does not want it seeding around liberally, the stalks should be cut off before seed ripens. It may also be propagated by dividing the clump. The showy nature of this grass is enhanced by the setting sun.

Poa abbreviata is the smallest of any of the true grasses listed above. Its specific name is descriptive as it grows only one to two inches high. It is perennial and survives in Zone 5 to 6. Propagate by dividing the clump or from seed which it occasionally sets. This little charmer makes a dense mat or turf similar to some of the larger lawn grasses. It then spreads laterally by underground runners. Its dark green leaves are tiny spikes that are more soft than rigid. Because of its similarity to lawn-type grasses, it can be used in the smaller rock garden or trough to create the effect of an alpine lawn.

Zoysia tenuifolia (Korean grass) is a small *Zoysia* that is much more fine and delicate than its coarse and more familiar relative, *Zoysia japonica*. *Z. tenuifolia* forms a thick, dense carpet of emerald green. According to references, it is not at all winter hardy. I found it growing as a tough and beautiful lawn grass in southern California. My plants have survived a winter here in Massachusetts (Zone 5 to 6) in a coldframe. Ultimately, I will try it outdoors, but not until it becomes better known and tried in many areas. It is probably hardy in the milder sections of the country and need not be limited to the deep south. It increases by rather long above-ground runners that root down at each node.

Final Comments

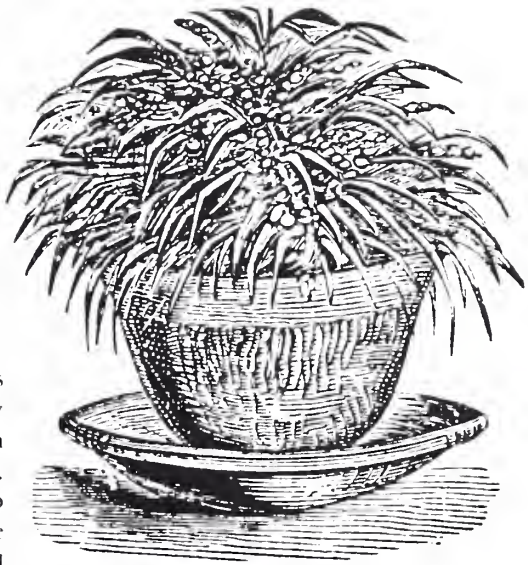
In the foregoing list of grasses I have not included any of the bamboos. Most are either too large for the average rock garden or else too invasive. Some are both. Many are not reliably winter hardy in colder areas. *Arundinaria viridistriata* was the only bamboo considered and this one only in one of its dwarf and more brilliantly colored forms. It is bright yellow and lights up the whole area especially when the light is dim such as evening or early morning. It appears to be winter hardy in my area (Zone 5 to 6), but it can be terribly invasive and should be watched closely. Due to its apparent variation in height and brilliance of coloring, search for the most desirable form or clone. They do vary, and it is a good idea to see this one growing before purchasing.

There are many grasses that have not been mentioned. Large and medium-to-large grasses have been omitted. Most are specimen plants and, except for unusual spots in larger rock gardens, are more attractive for the perennial border. There are a few genera of medium-to-small grasses that one might wish to investigate: *Acorus, Carex, Festuca* (fescues), *Juncus, Luzula* (wood rushes), *Melica* (melics) and *Poa*. Any reference books on grasses will suggest many others.

Grasses of Yesteryear

The following articles are taken from *The Ladies Floral Cabinet* published in New York City. This was an 11- by 14- inch newsletter of 24 pages, published monthly and dealing with houseplants and garden plants plus a new piece of sheet music bound into every issue. —P.L.

A nineteenth century couple admires some pampas grass.



A grass garden in a cup and saucer.

January, 1880:
New and Rare Plants

Of the many new and beautiful plants introduced to this country within the last few years, the *Eulalia japonica zebrina,** figured in this number, is certainly the most ornamental. It is exceedingly rare to find a plant with so many recommendations for popular favor. The plant is a hardy herbaceous perennial, of rapid growth, and of the most graceful habit. It grows from four to six feet in height. The flower stalks appear in September, with terminal panicles of brownish flowers, gracefully curved to one side, not unlike the ostrich plume. When dry, these flowers will last for years, making them particularly desirable for winter bouquets. A singular feature of this plant, as will be seen by the engraving, is the variegation, which is unlike that of any other plant, being across the leaf, instead of running longitudinally or of being in irregular blotches; these markings are regular and distinct, of creamy white with deep green, producing a most singular and pleasing effect. Without any exceptions, it is the most desirable and appropriate plant for the lawn yet introduced. This plant was discovered and brought out from Japan by Thomas Hogg, Esq., whose extensive researches there has given us many of our most popular plants, among the number being the hydrangea that bears his name, also the new climbing hydrangea. We are under obligations to Peter Henderson & Co., who first sent this plant out, for the illustration.

July, 1882:
***Juncus zebrinus*†, or Porcupine Plant**

This remarkable plant is a native of Japan, and was first introduced to cultivation by Thomas Hogg, Esq., of New York, who brought it with him some years since on his return from that country. He sent the whole stock to England, where "novelties" of merit are more highly appreciated than in this country, thus awarding the collector more liberally. This plant has a most peculiar appearance when growing, the idea suggested by a group of it being that of a cluster of porcupine quills, whence its common name. The plant, which is a true rush, throws up erect, terete leaves, but these instead of being green, are transversely banded with white and green, the colors being in most cases pretty evenly distributed; sometimes the white predominates, the surface being either wholly white, or the green bands being narrower and less conspicuous, but in the best marked leaves the green and white portions occupy alternately nearly equal bands of about half an inch deep. It is a most interesting plant, and being so entirely distinct and effective, it will, without doubt, come into general use, not only as an ornamental plant for the garden, but as a pot plant, and for window gardens, in hanging baskets, vases or other designs for growing plants.

For an opportunity to illustrate this plant we are under obligations to Messrs. Hallock, Son & Thorpe, of Queens, N.Y., who have imported recently from its native habitat a large quantity, which they intend soon to offer to the trade and

* *Eulalia japonica zebrina* now *Miscanthus japonicus* 'Zebrinus'

† *Juncus zebrinus* now *Juncus effusus* 'Zebrinus'

all others in search of this rare and beautiful plant. Messrs. Hallock & Thorpe consider this plant perfectly hardy. If so, it will greatly enhance its value.

From Vick's Illustrated Magazine *of the late 1800s comes the following letter about another popular grass of the last century, pampas grass.* —*P.L.*

Dear Mr. Vick:

I had no idea of the beauty of pampas grass until I came South to live. I now have in my garden the plumes that stand, I am quite sure, ten feet from the ground, while the leaves make a mound-like mass, certainly six feet in height. I don't know, but I presume that this grass is more natural to warm countries. I have a plant, or, perhaps a mass of plants, that now have forty of its beautiful spikes. These spikes, however, are not as beautiful as those I have seen in in the North, for they are not silvery-white, but a dull, greenish color, and do not look well when gathered for winter. What makes the difference? I do not know.

Mrs. S. E. I., Texas

Answer: Pampas grass‡, *Gynerium argenteum,* is a native of South America. The common name is given because it grows abundantly on the vast plains of that country, called Pampas. It was brought to this country and Europe about thirty years ago, and is now prized and cultivated wherever it can be grown successfully. It will not bear severe northern winters, and perhaps, cannot be grown successfully north of Philadelphia. The best plumes, such as are sold by florists for winter ornaments, and which are really beautiful, are grown in California, and their silvery-whiteness is obtained by bleaching. A few days' exposure to the sun removes all color. In this way all the grasses can be bleached, while those that it is thought best to keep in the natural color must be dried in the shade. The everlastings, also, should be cured in the shade.

‡ *Gynerium argenteum,* now *Cortaderia selloana*

In 1884, the Ladies' Floral Cabinet Co. of New York, published a book entitled Window Gardening. *The following material on Home Ornaments is taken from the fourteenth edition.* —*P.L.*

This department would not be complete without a word for the little ones of the house, some hint to them of what they can do to bring forth some glowing spot or sprig of living greenery. So we tell them how to make some pretty little contrivances in grasses, etc.

Plants with light, graceful foliage are every year becoming more popular; and to complete a picture of the highest order one requires a great variety of colors, and graceful pencilings; so in window gardening the culture of grasses adds greatly to the whole effect. Their feathery plumes may not possess brilliancy of coloring, but their silvery and emerald tints are an offset to their more gorgeous companions.

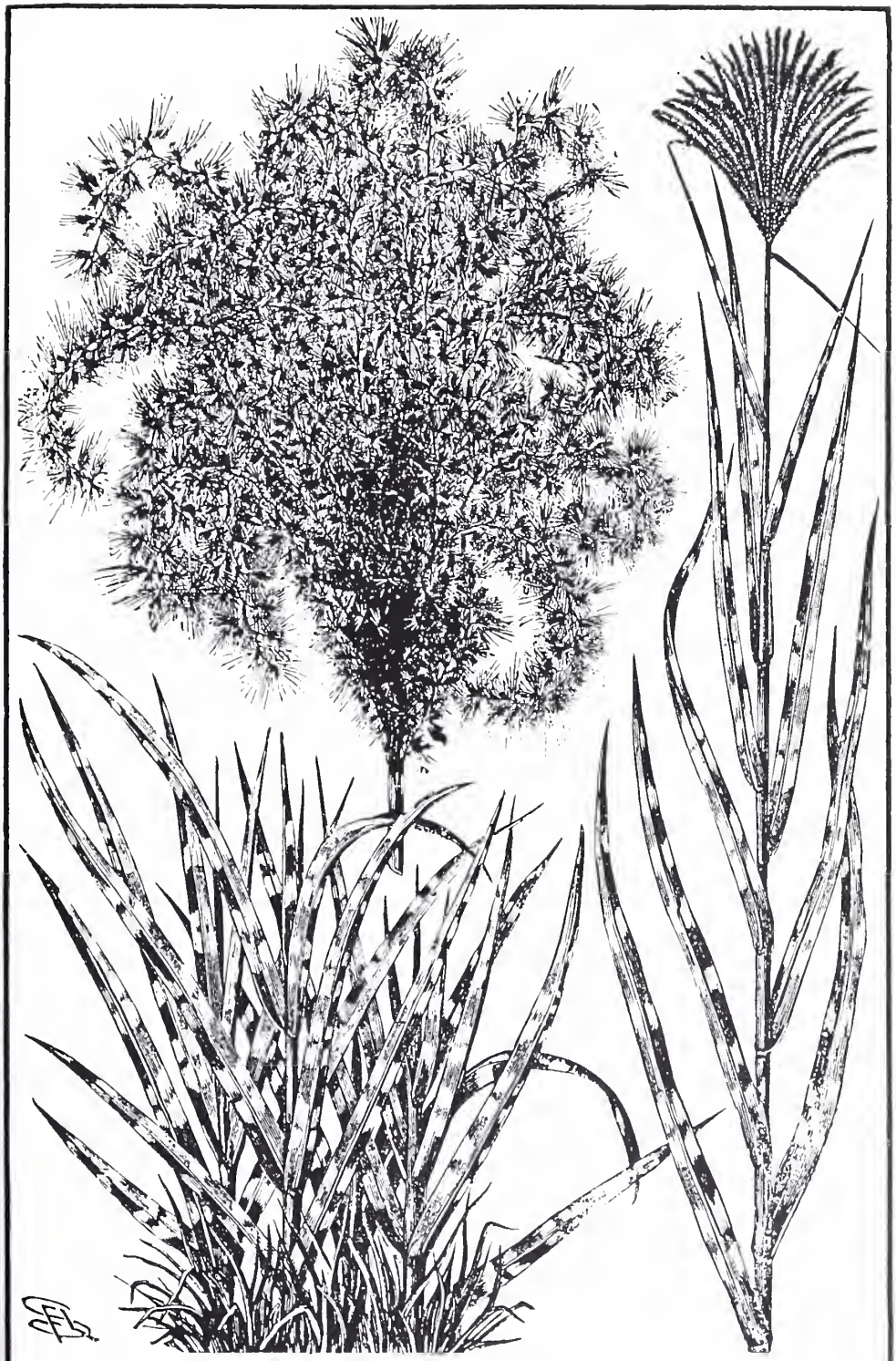
Far prettier than many a pretentious and costly ornament is a simple bowl of grasses planted in pine cones, set in sand, in moss or common soil.

If grown in cones—procure them from the woods, and sprinkle in as much soil as their scales will retain; then scatter the grass seeds over it, and sprinkle with water; place the cones in sand or moss—and be sure that they do not become dry—but water them sparingly at first, once a day, and set in a moderately warm place. Soon the seeds will sprout, and the tiny spears protrude in every direction.

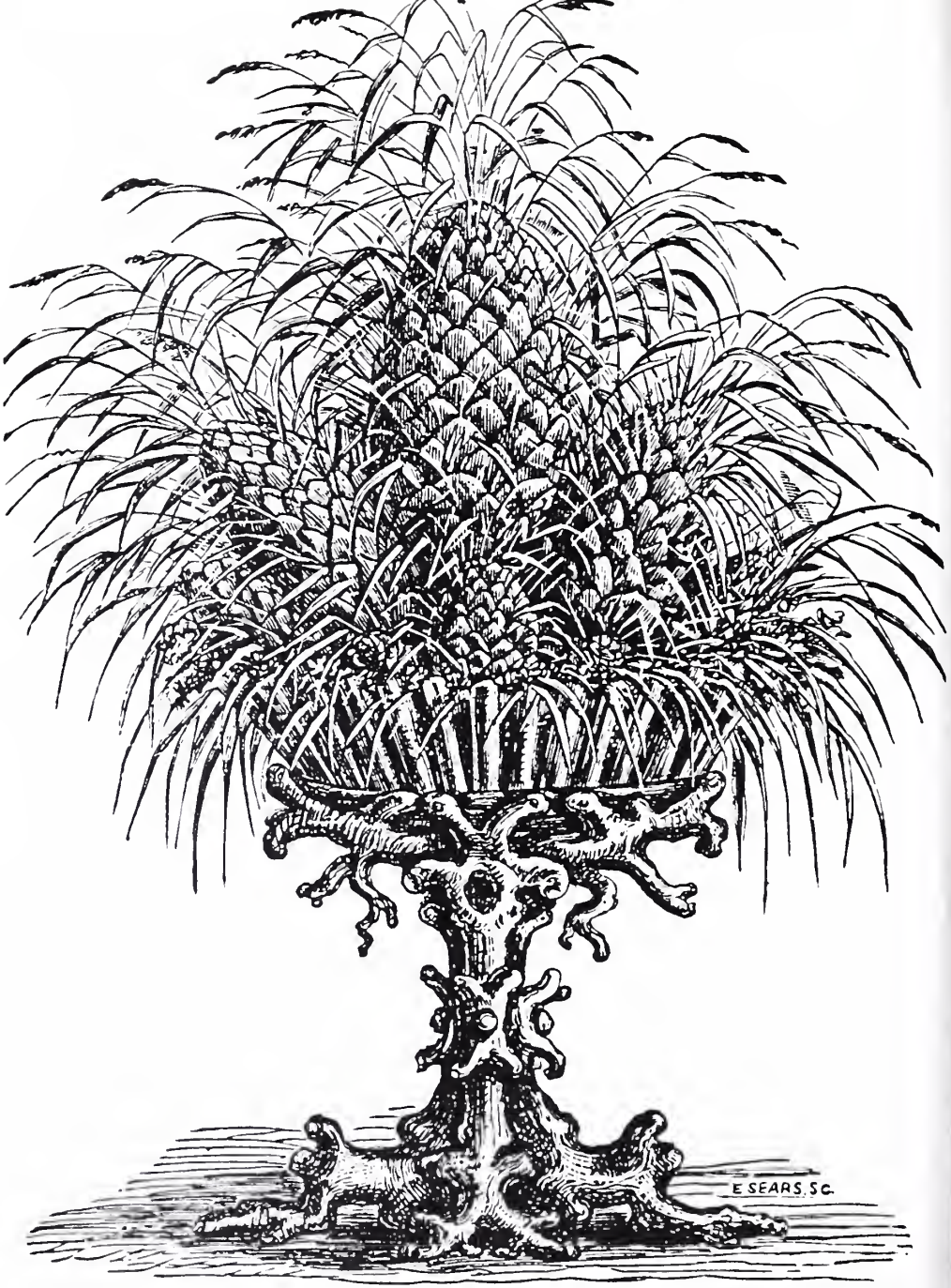
Grass will sprout and grow in pine cones without any soil, but it serves to prevent the cone from closing too tightly when sprinkled, and also makes a more vigorous growth. The cones can be suspended in a window, either singly or in groups of three fastened together with thread or wire; or a rustic basket or stand can be procured, and filled with cones with different kinds of grass, growing in each cone. There are three thousand different species of grasses in the world, and their study is a pleasing pursuit.

A very charming effect can be produced by placing a wet sponge in a glass bowl, and sprinkling over it canary seed, grass and flax seeds;

Zebra grass from a nineteenth century illustration.



Miscanthus japonicus *'Zebrinus'*



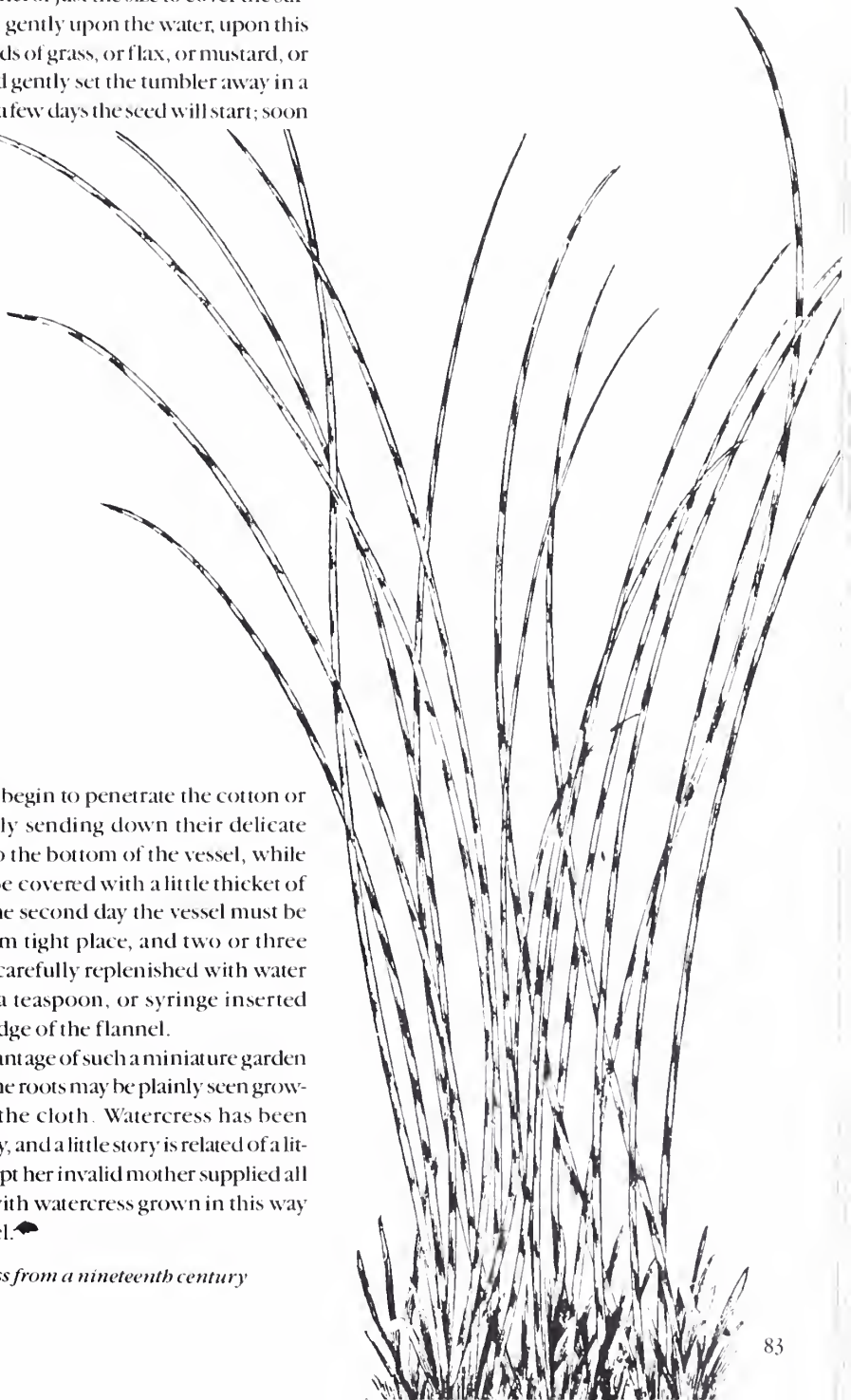
A more formal grass garden with seeds planted in pine cones.

soon it will be covered with a thick growth of fresh bright green; it must be judiciously watered; if kept too dry it will wither away; if too wet it may damp off. Mustard seed may also be used, and its tiny yellow blossoms, will be to many, a novelty as well as a delight.

Children and invalids can derive much pleasure from raising a grass garden; it is better to select the dwarf varieties, as the taller kinds require more nourishment.

A tumbler garden may be constructed as follows: Fill a common tumbler or goblet with water, cut out a round of cotton batting, or of soft thick flannel of just the size to cover the surface, and lay it gently upon the water, upon this scatter the seeds of grass, or flax, or mustard, or all mixed, and gently set the tumbler away in a dark place. In a few days the seed will start; soon the roots will begin to penetrate the cotton or flannel, slowly sending down their delicate white fibers to the bottom of the vessel, while the top will be covered with a little thicket of green; after the second day the vessel must be kept in a warm tight place, and two or three times a week carefully replenished with water by means of a teaspoon, or syringe inserted beneath the edge of the flannel.

A great advantage of such a miniature garden as this is that the roots may be plainly seen growing through the cloth. Watercress has been grown this way, and a little story is related of a little girl who kept her invalid mother supplied all winter long with watercress grown in this way on wet flannel.



Porcupine grass from a nineteenth century illustration.

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Annual Grasses for Garden and Bouquet

Few plants add more charm to a garden than the annual ornamental grasses. These are species grown not for the leaves but instead for the seemingly unending variety of their flowers.

Peter Loewer

Last night as I climbed the stairs in our old farmhouse I heard a rustle of dried leaves from atop the antique chest that sits in the corner by the banister. There our cat, Maude, was busily taking turns at pushing the cracked majolica vase towards the chest's edge and batting about the large bouquet of dried grasses that the vase contained.

Thwack! And a foot-long stem with the heavy seedhead of some foxtail millet snapped in three pieces. Swish! And the lovely silvery-bronze panicles of goldentop shattered in a hundred shards. I sprang forward but before I could reach the action, the black sorghum seeds stuck in her claws and the whole affair shot up towards the ceiling. Then with the synchronization of a fine watch, Maude pirouetted on a point in mid-air at the same instant that the pot and grasses smashed on the floor.

A bouquet of dried seed heads of annual grasses will last all winter in the house. The individual grasses are discussed on page 86.

Drawing by Peter Loewer

I couldn't be angry about it. The vase was broken to begin with and the cat spinning in the air within a shower of grass seeds was both high drama and entertainment rolled into one. Besides it was already January and in a few months the snow would melt and the sun warm the garden where these ornamental grasses are sown every season.

Of all the flowers in our garden the favorites are the annual ornamental grasses. Unlike their perennial relatives, these plants are rarely grown for their foliage which, except for the ornamental corns, looks weedy at best, but instead for the endless variety of their flowers and seeds. Whether planted out to relieve our dependence on the typical bedding annuals or to be gathered and dried for winter bouquets, the annual grasses deserve a place in many more gardens.

As a general rule, plants need a position with full summer sun for adequate growth and flowering, but they are not too fussy about soil conditions. As long as the soil drains and is capable of supporting a good crop of weeds, the annual grasses do quite well.

I usually start most of the seeds indoors in early spring since our local growing season only guarantees 90 to 120 days between frosts. In warmer climates, the seeds can be planted directly into the ground in April and on into May.

When planting these annual grasses prepare and mark the seedbed with care. The

new little plants look like any other grassy weed, which can lead to endless confusion and dismay. I was careless one year and lost almost a whole crop of hare's-tail grass to the strangling stolons of crabgrass before I realized what was afoot.

As seedlings grow to one and two inches tall, thin them to six or twelve inches between each plant, depending on the ultimate height. Wild oats, for example, should be about one foot apart, while the hare's-tail grass is happy in a six-inch space. Also, be generous with the seed—the smaller grasses look better when planted in substantial drifts of the same species. Remember to collect seed for coming seasons. Because none of these grasses are hybrids, all will grow true from seed. Store them in carefully marked packages (stamp or coin envelopes are excellent) in a cool, dry place.

The drawing illustrates the following grasses: (1) Foxtail millet *(Setaria italica)* grows between two and four feet tall and looks exactly like the foxtail that teenagers of the 1930s tied on the rumble seats of their old Ford coupes. The dense panicles are often up to a foot in length and bow towards the earth with the weight of the seeds. While the plants are tolerant to some dryness, they perish quickly under drought conditions. This particular grass was cultivated in Ancient China (2700 BC), reached Europe during the Middle Ages, and in 1849 entered the United States, where it has become an important fodder crop. The seed is harvested for bird feed. A group of these grasses is stunning in the garden border and a bowl full of the panicles can make a striking addition to a room lasting as long as you have the patience to dust them or until your cat decides to play.

(2) Variegated corn (*Zea mays* 'Variegata') grows up to six feet tall, but usually hovers between three or four. Unlike the other annual grasses, it is grown for its beautifully shaded leaves that are striped with green, red, pink, and wide bands of pure white. The cobs never grow very large; the silk just adds interest to the plants. Corn is a heavy feeder, so unlike the other grasses, fertile soil is needed and never skimp on the water. Try growing these corns in eight-inch pots, grouping them on the terrace for an effective outdoor decoration.

(3) Goldentop *(Lamarckia aurea)* will grow about 20 inches tall. Named after J.B. Lamarck, the naturalist who lost out to Darwin in the evolutionary sweepstakes, goldentop is my favorite flower both for cutting and the front of the border. The one-sided panicles have a shimmering look when fresh and become a tarnished silver-green with age. By midsummer the plants are turning brown, so a second crop should be prepared. The flowers shatter easily when dry so be sure to pick them before they mature. Goldentop is found growing as a weed in the southwestern United States.

(4) Quaking grass *(Briza maxima)* reaches three feet in height during a good summer season. A native of southern Europe, this grass has been in cultivation as a garden ornament for well over 200 years. The spikelets shake and quiver with every gentle motion of the breeze. They are faintly striped with purple and a most attractive addition to the bouquet. Quaking grass should be limited to the cutting garden—it's a bit too ungainly for a prominent place in the garden proper. Pick the panicles before they open.

(5) Brome grass *(Bromus madritensis)* will reach two feet in height. It is one of a number of species in the genus eminently qualified for both garden and vase. The flowers retain all their grace when dried, and the leaf tips of the species shown become tinged with auburn as they ripen. There are usually three or four species listed in seed catalogs.

(6) Hare's-tail grass *(Lagurus ovatus)* grows between 18 and 20 inches tall. Both the light green foliage and the stems are soft with down. This grass has been cultivated for centuries as it produces numerous terminal spikes of cottony fluff before the first killing frost kills the plants. It's always been a favorite for winter bouquets because the flower heads will not shatter with age. Sadly, their

very durability has led to unending mistreatment by people who dye the seedheads chartreuse or magenta, pop them in plastic vases, and sell them at highway rest stops.

(7) Champagne grass *(Rhynchelytrum repens)* will form large clumps of leaves up to four feet tall. Still called *Rhynchelytrum roseum* or *Tricholaena rosea* in seed catalogs that should know better, its other common names are ruby grass or natal grass. An annual in the North, it becomes a worrisome perennial whenever yearly temperatures stay above freezing. Floridians beware: this plant can become a pesky weed. The reddish-pink plumes turn a soft silver with age and are great cut flowers. They can be dried for winter bouquets, but use great care—they shatter easily. When gathering champagne grass, pull the stems rather than breaking or cutting them.

(8) Canary grass *(Phalaris canariensis)* grows three feet tall. A native of the Canary Islands and southern Europe, the plant is used to produce birdseed for both wild and domesticated canaries. Because the paper that lines the bottom of a birdcage often winds up at the local landfill, Canary grass is usually found at every such spot. The flower heads are a variegated green and yellowish white at the top of long and slender stems, but the plant itself is not at all attractive and should be kept to the cutting garden.

(9) Feathertop grass *(Pennisetum villosum)* is a two-to-three-foot-high annual in the North but perennial in the South. Often listed as *Pennisetum longistylum* in catalogs, the grass is floppy in appearance as the magnificent blossoms can be quite heavy. If picked before they open entirely, they can be dried for bouquets but they shatter easily with the slightest bump. Feathertop is most attractive as a cut flower and a lovely addition to any summer bouquet.

(10) Bearded wheat *(Triticum turgidum)* grows to four feet. The tradition of cultivating this hardy annual reaches far back in time. Its seeds are ground to become durum flour. Grown in most arid regions of the world because of its resistance to drought, the long seeds that appear to be bearded are unlike any others in the grass kingdom. The flowering stalks are a decorator's delight.

(11) Black sorghum *(Sorghum bicolor* var. *technicus)* will reach six feet in a good summer season. The sorghums have been used since prehistoric times and man has approached the species with an inventive mind. The sweet sap of some varieties is used for molasses, a second variety is used for making flour, a third is grown strictly for silage and cattle fodder, and a fourth is grown specifically for broomstraws. The shiny black seed heads of the specimen in the vase can spruce up floral arrangements. Even the cornlike leaves with their light green color deftly spattered with brown can be very effective when added to cut flowers. This is a very tender plant and should never be planted out before frost dangers are past.

(12) Foxtail grass *(Setaria lutescens)* will grow about two feet tall. It is a relative of foxtail millet and originally introduced as a common weed from Europe. It has become a common weed here, too. But the yellow-orange bristles of the seed heads are quite beautiful and retain their color after drying. In fact, a massive arrangement of 50 to 60 stems can cause even the most sophisticated gardener to ask where they are found and how much they cost.

(13) Job's tears *(Coix lacryma-jobi)* is a close relative of corn and will often grow to four feet in height. This plant has the distinction of being the oldest ornamental grass in cultivation—hardly a cloistered garden in the 14th century was without a row of these plants. The seeds fall readily from the plant at maturity and are very, very hard, colored with streaks of gray or black on white. The seeds are often utilized in the manufacture of rosaries. Job's tears will tolerate some shade and prefers a dampish spot in the garden. In colder climates start the seeds indoors to get a head start.

(14) Dragon's claw millet *(Eleusine coracana)* is an annual growing between two

and three feet tall. The heads resemble what could be a dragon's foot or the talons of a hefty bird. They also resemble something embroidered by a Victorian lady for a beaded purse. The grass is grown in Africa and Asia where it's called finger millet and used for flour and occasionally turned into a beer called *M'Poko.* Very good for dried bouquets, and unusual rather than beautiful in the garden.

(15) Wild oats *(Avena fatua)* grows up to four feet tall and is considered by most eastern farmers to be nothing but a troublesome weed. It can be found growing along many roadsides in high summer. Even for a grass the plants look straggly, but the flowers dry to a beautiful shade of light brown. A more civilized species called animated oats *(A. sterilis)* has a larger flower. The name animated refers to the needlelike spike that protrudes from the seed head and moves about as humidity changes.

If you would like to gather some grasses for winter bouquets, pick the stems on a dry and sunny day after the dews of morning have evaporated. Choose flowers that have not yet completely opened and cut the stems as long as you can—they can be trimmed later. Strip any excess leaves, tie small bunches of stems together, and hang them upside down on wire coat hangers, leaving plenty of air space between each bunch, in a cool, dry and airy room. Check the bundles every few days as the stems will shrink as they dry and some could fall to the floor and shatter. It should take between two and three weeks for the drying process.

Briza maxima, *quaking grass, is planted here with nicotiana. Pick the panicles before they open for use in dried arrangements.*

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Photo by Elvin McDonald

Grasses from Seed to Plant

A nurseryman from North Carolina tells how to start many grasses from seed.

—P.L.

Majella Larochelle

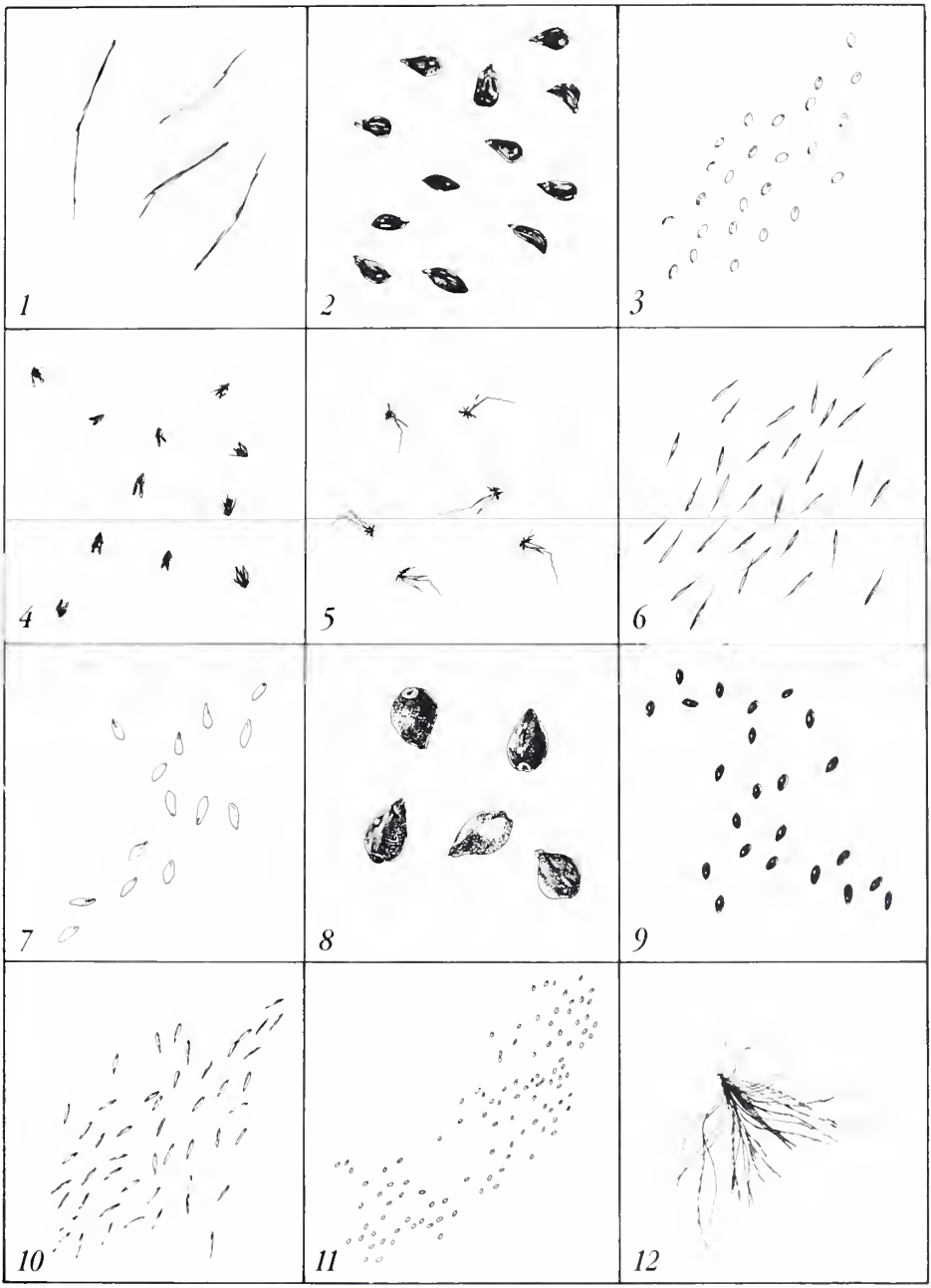
Seeds of grasses must be collected at the proper time to ensure germination—usually when they begin to fall off the plant. Many species have a long hair (awn) at the end of the seed. When the awn appears, it is time to harvest the seed.

Discard any debris mixed with the seed, since often the decomposition of this vegetable matter leads to the rotting of the seed before it germinates. Store seed in a cool, dry place away from excessive heat and moisture.

Given the correct treatment at sowing, most grasses will germinate. Once sown, provide enough moisture to the seed pan. Continue to be careful about water after transplanting, since even grasses from the drylands of the world require ample moisture in the juvenile stage.

The following list gives various treatments of seed at the time of sowing.

Majella Larochelle is an expert in the study of seeds. He owns and operates a nursery headquartered in Asheville, North Carolina, and maintains a large seed collection, with specimens gathered from around the world. His selection of grass seeds is extensive.



Drawing by Peter Loewer

The accompanying illustration shows the seeds of 12 grasses at about actual size: (1) Bromus madritensis, *(2) strawberry corn, (3)* Setaria glauca, *(4) champagne grass, (5) zebra grass, (6)* Festuca glauca, *(7) canary grass, (8) Job's tears. (9) black sorghum, (10)* Koeleria glauca, *(11)* Eragrostis tef, (12) Pennisetum longistylum.

Easy to Germinate	Remarks
Aegilops ovata–annual goat grass	Germinates in 4 weeks.
Agropyron spicatum–bluebunch wheat grass	Germination variable.
Agropyron trachycaulum–slender wheat grass	
Agrostis gigantea (A. alba)–red top	
Agrostis nebulosa–cloud grass	Germinates in 3 weeks outdoors.
Agrostis stolonifera–bent grass	Give additional light.
Aira caryophyllea–hairgrass	
Alopecurus pratensis–meadow foxtail	Give additional light during germination.
Ammophila breviligulata–American beach grass	Slow germination.
Andropogon virginicus–broomsedge	
Anthoxanthum odoratum–sweet vernal grass	Give additional light during germination.
Aristida basiramea–forktip three-awn grass	
Aristida purpurea var–*longiseta*–Fendler three-awn grass	10-60 % germination.
Aristida purpurea–purple three-awn grass	10-60 % germination.
Arrhenatherum elatius–tall oat grass	
Arena spp.–oats	Germinates in 3 weeks.
Bouteloua curtipendula–side oats grama	Good germination if you keep the seed dry for 2 months.
Bouteloua eriopoda–black grama	
Bouteloua gracilis–blue grama	
Bouteloua hirsuta–hairy grama	
Brachypodium sylvaticum–false brome	Slow germination.
Briza maxima–big quaking grass	Germinates in 4 weeks.
Briza media–quaking grass	Slow germination.
Briza minor–little quaking grass	
Bromus briziformis–rattlesnake chess	Germinates in 4 weeks.
Bromus unioloides–rescue grass	

Easy to Germinate	Remarks
Bromus grandis–brome grass	
Bromus japonicus–Japanese brome	
Bromus vulgaris var. *eximius*–brome grass	
Bromus lanceolatus (B. macrostachys)–European brome	Germinates in 4 weeks.
Bromus madritensis–compact brome	Germinates in 4 weeks.
Bromus hordeaceus–*(B. mollis)* soft chess	
Bromus spp.–Brome grass	Give additional light during germination.
Bromus tectorum–downy brome	
Buchloë dactyloides–buffalo grass	Let the seed age before sowing.
Calamovilfa longifolia–prairie sandreed	
Carex buchananii—leatherleaf sedge	Germinates in 4 weeks.
Carex muskingumensis	
Carex pseudo-cyperus	
Carex sylvatica	
Coix lacryma-jobi–Job's-tears	
Cortaderia selloana–pampas grass	Germinates in 3 to 4 weeks at 70 °F.
Corynophorus canescens–gray hair grass	Slow germination.
Cynosurus echinatus–dog's-tail grass	Germinates in 4 weeks.
Cyperus spp.	Germinates in 4 weeks.
Danthonia parryi–parry oat grass	50 % germination.
Deschampsia caespitosa–tufted hair grass	Slow germination.
Echinochloa crus-galli–barnyard grass	
Eleocharis compressa–spikerush	
Eleusine indica–goose grass	Treat the seed first with 0.2 % potassium nitrate.
Elymus cinereus–basin wildrye	Use full seed only.
Elymus glaucus–blue wildrye	
Elymus triticoides–beardless wildrye	

Easy to Germinate	Remarks
Eragrostis curvula–weeping love grass	Give additional light.
Eragrostis spectabilis–purple love grass	
Eragrostis tef (E. abyssinica)–Teff	Germinates in 4 weeks.
Eragrostis trichodes–Sand love grass	
Erianthus contortus–bent-awn plume grass	Slow germination.
Erianthus ravennae–ravenna grass	
Festuca amethystina–large blue fescue	Slow germination.
Festuca gigantea–giant fescue	Slow germination.
Festuca cinerea	Slow generation.
Festuca pulchella	Slow germination.
Glyceria striata–fowl manna grass	
Hilaria belangeri–curly-mesquite	Use only fresh seed.
Hilaria jamesii–galleta grass	Use only fresh seed.
Hilaria mutica–tobosa grass	10-50% germination.
Holcus lanatus–velvet grass	Give additional light during germination.
Hordeum jubatum–squirreltail barley	Germinates in 2 weeks at 60°F.
Hystrix patula–bottlebrush grass	Slow germination.
Juncus acutus–sharp rush	
Juncus alpinoarticulatus (J. alpinus)–alpine rush	Germinates in 2 weeks
Koeleria glauca–large blue hair grass	
Lagurus ovatus–hare's-tail grass	Germinates in 3 weeks at 65°F with fresh seed.
Lamarckia aurea–goldentop	Germinates in 3 weeks.
Lolium multiflorum–Italian ryegrass	
Luzula nivea–showy woodrush	Slow germination.
Luzula pilosa–hairy woodrush	Slow germination.
Luzula sylvatica–great woodrush	Slow germination. True from seed.
Mibora minima–early sand grass	Germinates in 3 weeks at 50°F.
Milica ciliata–hairy melic grass	Slow germination.

Easy to Germinate	Remarks
Milium effusum–wood millet	Germinates in 4 weeks.
Miscanthus sacchariflorus–Amur silver grass	
Miscanthus sinensis–eulalia	
Miscanthus sinensis "New Hybrid"	True from seed.
Muhlenbergia arenicola–sand muhly	Poor germination.
Muhlenbergia cuspidata–plains muhly	
Muhlenbergia glomerata–green muhly	
Muhlenbergia porteri–bush muhly	Poor germination
Muhlenbergia racemosa–green muhly	
Panicum capillare–witch grass	Germinates in 4 weeks.
Panicum clandestinum–deertongue grass	
Panicum dichotomiflorum—fall panicum	Alternate daily warm & cold.
Panicum lanuginosum–hairy panic grass	
Panicum leibergii–prairie panic grass	
Panicum linearifolium–slimleaf panic grass	
Panicum miliaceum–proso millet	Germinates in 4 weeks.
Panicum obtusum	Alternate daily warm & cold.
Panicum virgatum–switch grass	
Paspalum dilatatum–dallis grass	Treating the seed with potassium nitrate will help.
Paspalum urvillei–vasey grass	Scarify the seed coat or treat the seed with potassium nitrate.
Pennisetum flaccidum	Slow germination.
Pennisetum setaceum–fountain grass	Germinates in 3 weeks at 70°F.
Pennisetum villosum–feathertop	Germinates in 3 weeks at 70°F.
Phalaris arundinacea–reed canary grass	
Phalaris canariensis–canary grass	Germinates in 3 weeks.
Phragmites australis (P. communis)–common reed	Keep the seed wet.

Easy to Germinate	Remarks
Poa alpina–alpine blue grass	
Poa chaxii–broad-leaved meadow grass	Slow germination.
Poa palustris–fowl meadow grass	
Poa sandbergii–Sandberg's blue grass	
Poa spp.–blue grass	Treat the seed with potassium nitrate.
Polypogon monspeliensis–rabbitfoot grass	Germinates in 4 weeks.
Rhynchelytrum repens—natal grass	Germinates in 4 weeks at 70° F.
Schizachyrium scoparium–little bluestem *(Andropogon scoparius)*	Slow germination.
Scirpus clintonii–bulrush	
Scirpus lacustris	Keep the seed wet.
Scirpus micronatus	Slow germination.
Scirpus sylvaticus	Slow germination.
Sesleria autumnalis	Slow germination.
Sesleria benfleriana	
Setaria italica–foxtail millet	Germinates in 4 weeks.
Sitanion hystrix–squirreltail	
Sitanion jubatum–big squirreltail	
Sorghastrum nutans–Indian grass	Slow germination.
Sparganium minimum–bur-reed	Will take 2 months to germinate.
Spartina pectinata–prairie cord grass	
Sphenopholis obtusata var. *major (S. intermedia)*–wedge grass	
Spodiopogon sibiricus	Slow germination.
Sporobolus heterolepsis–prairie dropseed	
Stipa calamagrostis (Achnatherum calamagrostis)–silver grass	Slow germination.
Stipa capillata–feather grass	Slow germination.
Stipa coronata–crested stipa	
Stipa extremiorientialis–*(Achnatherum pekinense)*	Slow germination.
Stipa lettermani–Letterman needlegrass	
Stipa pulchra–purple needlegrass	

Easy to Germinate	Remarks
Stipa speciosa–desert needle grass	
Stipa tenacissima	Slow germination.
Stipa thurberiana–Thurber needle grass	Give additional light during germination.
Taeniatherum caput-medusae–medusa head	Keep in a warm place for first two weeks.
Themeda japonica	Slow germination.
Tridens flavus–tall redtop	
Triticum spp.–wheat	Germinates in 10-20 days.
Vulpia microstachys–small-fescue	
Vulpia octoflora–six-weeks-fescue	
Xerophyllum tenax–beargrass	Slow germination.
Zea mays–corn	Germinates in 2-4 weeks at 65° F.
Zizania aquatica–wild-rice	Germinates in 4 weeks.

Keep in a warm place for two to four weeks.	Remarks
Chasmanthium latifolium (Uniola latifolia)–spangle grass	
Eragrostis curvula var. *conferta*–Catalina Boer love grass	High germination.
Eragrostis lehmanniana–Lehmann love grass	High germination.
Luzula alopecurus	30 days to germinate.
Luzula lutea	30 days to germinate.
Pennisetum alopecuroides–fountain grass	
Sparganium erectum–branched bur-reed	
Typha angustifolia–narrow-leaved cat-tail	
Typha latifolia–common cat-tail	

Sow and keep in a cool place for at least one week.	Remarks
Aegilops kotschyi–goat grass	
Aegilops longissima–goat grass	Prefers calcareous soil.
Agrostis capillaris (A. tenuis)–colonial bent grass	Give additional light.
Andropogon gerardii–big bluestem	
Calamagrostis canadensis–bluejoint	Give additional light.
Carex spp.–Sedge	Give additional light.
Cenchrus ciliaris–buffel grass	Germination variable. Give additional light.
Dactylis glomerata–orchard grass	Give additional light.
Elymus canadensis–Canadian wildrye	
Festuca idaboensis–Idaho fescue	Poor germination. Give additional light.
Festuca ovina–sheep's fescue	May germinate in 2 weeks at 70 °F. Give additional light.
Hierochloë odorata–vanilla grass, sweet grass, holy grass	
Koeleria pyramidata–June grass	
Lolium spp.–ryegrass	Give additional light.
Melica stricta–rock melic grass	
Phleum pratense–Timothy	Give additional light.
Poa bulbosa–bulbous meadow grass	Treat the seed with potassium nitrate.
Puccinellia lemmonii–Lemmon's alkali grass	Poor germination. Treat the seed with potassium nitrate.
Sporobolus airoides–alkali sacaton	50 % germination. Give additional light.
Sporobolus asper–rough dropseed	
Sporobolus cryptandrus–sand dropseed	Give additional light.
Sporobolus giganteus–giant dropseed	50 % germination. Give additional light.
Stipa spartea–porcupine grass	
Trisetum spicatum–spike trisetum	Variable. Give additional light.

Give six weeks of cold followed by one month of warm.	Remarks
Andropogon ballii–sand bluestem	Give additional light.
Carex acuta (C. gracilis)–slender tufted sedge	
Carex grayi	
Carex pendula (C. maxima)–pendulous sedge	
Carex punctata–dotted sedge	
Helictotrichon sempervirens (Avena s.)–blue oat grass	
Juncus ensifolius	
Molinia caerulea subsp. *arundinacea*	
Molinia caerulea–purple moor grass	
Psathyrostachys junceus (Elymus junceus)	Give additional light.
Stipa barbata	
Stipa pennata–European feather grass	
Stipa viridula–green needle grass	Poor germination. Give additional light.

Seed scarification or acid treatment will help	Remarks
Danthonia spicata–poverty oat grass	50 % germination
Oryzopsis hymenoides–Indian ricegrass	
Stipa comata–needle-and-thread grass	

Give additional light during germination	Remarks
Agropyron smithii–Western wheat grass	Poor germination without a potassium nitrate soaking.
Agrostis canina–velvet bent grass	Treat the seed with potassium nitrate.
Agrostis gigantea–redtop	Treat the seed with potassium nitrate
Chloris gayana (A. alba)–rhodes grass	Treat the seed with potassium nitrate.
Cynodon dactylon–Bermuda grass	Irregular. Treat the seed with potassium nitrate.

Annual Grasses

Botanical Name	Common Name	Height	Flowering Period	Sources*
Agrostis nebulosa	Cloud grass	18″	4–10 wks.	2, 7
Avena sterilis	Animated oats	3′	4–6 wks.	5, 7
Briza maxima	Quaking grass	2′	6–10 wks.	2, 6, 7
Briza minor	Little quaking grass	9–12″	4–6 wks.	2, 4, 7
Bromus lanceolatus (B. macrostachys)	Brome grass	2′	6–10 wks.	2
Coix lacryma-jobi	Job's-tears	2–3′	10+ wks.	4, 6, 7
Eragrostis elegans	Love grass	18–24″	10+ wks.	4, 7
Hordeum jubatum	Squirreltail-barley	18–24″	6 wks.	2, 7
Lagurus ovatus	Hare's-tail grass	12–18″	10+ wks.	2, 4, 6, 7
Lamarckia aurea	Goldentop	1′	6–10 wks.	4
Leptochloa fascicularis	Spike grass	2½′	6–10 wks.	4
Panicum miliaceum (P. violaceum)	Panic grass	3′	6–10 wks.	7
Pennisetum setaceum (P. ruppelii)	Fountain grass	4′	10+ wks.	1, 6
Pennisetum villosum (P. longistylum)	Feathertop	2′	6–10 wks.	7
Phalaris canariensis	Canary grass	2–4′	4–6 wks.	2, 7
Polypogon monspeliensis	Rabbitfoot grass	18″	6–10 wks.	7
Rhynchelytrum repens (syn. Tricholaena roseum)	Natal grass	1–2′	10+ wks.	4,7
Setaria lutescens (S. glauca)	Glaucous bristle grass, yellow bristle grass	18–30″	10+ wks.	7
Setaria italica	Foxtail millet	2′	6–10 wks.	4
Triticum spelta	Spelt wheat	2′	4–6 wks.	2, 7
Triticum turgidum (T. durum)	Durum wheat	2′	4–6 wks.	2

Selected Sources for Ornamental Grasses

1) Kurt Bluemel, Inc., Nurseries, 2543 Hess Rd., Fallston, MD 21047;

2) The Country Garden, Rt. 2, Crivitz, WI 54114;

3) Endangered Species, Box 1830, Tustin, CA 92681-1830;

4) J.L. Hudson, Box 1058, Redwood City, CA 94064;

5) Logee's Greenhouses, 55 North St., Danielson, CT 06239;

6) Park Seed Co., Greenwood, SC 29647-0001;

7) Thompson and Morgan, Box 1308, Jackson NJ 08527;

8) Wayside Gardens, Hodges, SC 29695-0001.

References

Grounds, Roger. *Ornamental Grasses.* New York: Van Nostrand Reinhold, 1981.

Loewer, H. Peter. *Growing and Decorating with Grasses.* New York: Walker and Company, 1977.

Meyer, Mary Hockenberry. *Ornamental Grasses.* New York: Charles Scribner's Sons, 1975.

Chart Codes

Form

I = Irregular
M = Mound
OS = Open-spreading
T = Tufted
UA = Upright-arching
UN = Upright-narrow
UO = Upright-open

Uses

S = Sun
PSh = Partial shade
Sh = Shade
Sp = Specimen
G = Groups
M = Massing
Sc = Screen
GC = Ground cover
E Edging
DS = Dry soil
MS = Moist soil
RG = Rock garden
FC = Fall color
DF = Decorative flowers
N = Naturalizing

Perennial Grasses

USDA Hardiness Zone	Botanical Name	Common Name	Ht.	Form*	Uses*	Sources*
6–7	*Alopecurus lanatus*	Wooly foxtail	1′	T	S, RG	1
6–9	*Alopecurus pratensis* 'Aureus'	Yellow foxtail, meadow foxtail	1′	T-UO	S, G, M, RG	1
4–9	*Andropogon gerardii* (See Schizachyrium/ scoparium)	Big blue stem	4–6′	UA	S, G, M	1
4–9	*Anthoxanthum odoratum*	Sweet vernal grass	2′	UA–UN	S, DS	4
4–9	*Arrhenatherum elatius bulbosum* 'Variegatum'	Bulbous oat grass	1–2′	T-UO	S, PSh, M, RG	1
7–10	*Arundo donax*	Giant reed	9–12′	UA–UO	S, Sp, Sc, DF	1
8–10	*Arundo donax* 'Variegata'	Striped giant reed	5–7′	UA–UO	S, Sp, Sc	1
4–9	*Bouteloua curtipendula*	Side oats grama	2–3′	UA–UN	S, M	1
4–9	*Bouteloua gracilis*	Blue grama	1–2′	T-UO	S, G, RG, N, DF	1
4–8	*Briza media*	Quaking grass	2–3′	UO	S, M, N, DF	1,2
6–9	*Bromus ramosus*	Brome grass	3–4′	T	S, PSh, G	1
5–9	*Calamagrostis acutiflora stricta*	Feather reed grass	5–7′	UA–UN	S, G	1, 8
6–9	*Calamagrostis* x *arundinacea brachytricha*	Korean reed grass	2–3′	UA–UN	S,PSh, G	1
6–8	*Chascolytrum subaristatum* (Syn. Briza subaristata)	Quaking grass	1′	UA–UN	S, RG	1
5–9	*Chasmanthium latifolium* (Syn. Uniola)	Spangle grass	3–5′	UA–UN	Sh, G, M, N, FC	1
8–10	*Cortaderia richardii* (Syn C. conspicua)	Black pampas	5–10′	UN–UO	S, Sp, Sc, DF	1
8–10	*Cortaderia selloana*	Pampas grass	8–12′	UN–UO	S, Sp, Sc, DF	1, 4, 6, 8
8–10	*Cortaderia selloana* 'Argenteum'	Silvery blooming pampas grass	9–12′	UN–UO	S, Sp, DF, Sc	1
7–10	*Cortaderia selloana* 'Rendatleri'	Pink pampas grass	8–10′	UN–UO	S, Sp, DF, Sc	8
8–10	*Cortaderia selloana* 'Rosa Feder'	Pink pampas grass	9–12′	UN–UO	S, Sp,DF, Sc	1
8–10	*Cortaderia selloana* 'Sunningdale Silver'	Pampas grass	6–9′	UN–UO	S, Sp, Sc, DF	1
8–10	*Cortaderia selloana* 'Pumila'	Compact pampas grass	4–6′	UN–UO	S, Sp, DF	1
9–10	*Cymbopogon citratus*	Lemon grass	3–6′	I–UA	S, Sp, G	1
5–9	*Dactylis glomerata* 'Variegata'	Cock's-foot orchard grass	1–2′	UO	S, PSh, G, E	1
4–9	*Deschampsia caespitosa*	Tufted hair grass	2′	T–M	S, PSh, G, M, RG, N, DF	1
4–9	*Deschampsia caespitosa* 'Bronzeschleier'		3′	T–M	S, PSh, G, M	1
4–9	*Deschampsia caespitosa* 'Goldgehaenge'		3′	T–M	S, PSh, G, M	1
6–9	*Deschampsia caespitosa* 'Goldschleier'		2–3′	T–M	S, PSh, G, M	1
6–9	*Deschampsia caespitosa* 'Goldstaub'		2–3′	T–M	S, PSh, G, M	1
4–9	*Deschampsia caespitosa* 'Schottland'	Scottish tufted hair grass	4–6′	T–M	S, PSh, G, M	1
4–9	*Deschampsia caespitosa* 'Tautraeger'		3′	T–M	S, PSh, G, M	1
4–9	*Deschampsia caespitosa tardiflora*	Late-blooming tufted hair grass	3′	T–M	S, PSh, G, M	1
4–9	*Deschampsia flexuosa*	Crinkled hair grass	2 ½′	T-UO	S, PSh, RG, DF	4

USDA Hardiness Zone	Botanical Name	Common Name	Ht.	Form*	Uses*	Sources*
5–9	*Deschampsia caespitosa vivipara* 'Fairy's Joke'	Viviparous hair grass	3′	T	S, PSh, G, M	1
5–9	*Elymus* 'Vahl Glaucus' (Syn. Leymus racemosus)	Giant blue wildrye	3–6′	UA	S, G, M	1
4–9	*Elymus glaucus*	Blue wildrye	2–4′	1	S, G, GC	1
7–9	*Erianthus contortus*	Bent-awn plume grass	5–6′	UC	S, PSh,MS	1
7–9	*Erianthus giganteus*	Sugarcane plume grass	3–9′	UO	S, Sp, G	1
6–9	*Erianthus ravennae*	Ravenna grass	9–12′	UO	S, Sp, Sc, DF	1
7–9	*Erianthus strictus*	Narrow plume grass	3–6′	T-UN	S, G, M	1
4–8	*Festuca amethystina* 'April Gruen'	Olive-green fescue	8″	T	S, M, GC, RG	1, 3
4–8	*Festuca amethystina* 'Bronzeglanz'	Bronze fescue	8″	T	S, M, GC, RG	1, 3
4–9	*Festuca cinerea superba*	Blue fescue	6″	T	S, M, E	1
4–9	*Festuca orina glauca*	Dwarf blue fescue	8–12″	T	S, M, E, RG, GC	4, 6, 7
5–8	*Glyceria maxima* 'Variegata'	Manna grass	2–3′	I	S, M	1
7–9	*Hakonechloa macra* (Syn. Phragmites macra)		2′	M	PSh, G, GC	
7–9	*Hakonechloa macra* 'Aureola'	Golden variegated hakonechloa	1–2′	M	PSh, G, M, GC	1, 3
4–8	*Helictotrichon sempervirens* (Syn. Avena)	Blue oat grass	2′	T	S, G, M, RG	1
5–9	*Holcus lanatus*	Velvet grass	1–3′	UA–UN	S, G	1

*See p. 96 *for keys to form, use and source codes.*

Miscanthus sinensis *'Variegatus' grows in a bed of mixed perennials and annuals at the Conservatory Garden in New York.*

Photo by Elvin McDonald

USDA Hardiness Zone	Botanical Name	Common Name	Ht.	Form*	Uses*	Sources*
7–9	*Holcus lanatus* 'Variegatus'	Variegated velvet grass	8″	T–OS	S, PSh, G, GC, RG	1
5–6	*Hystrix patula*	Bottlebrush grass	3′	UO	S, PSh, G, M, N, DF	1
7–9	*Imperata cylindrica rubra*	Japanese bloodgrass	1–2′	M–OS	S, PSh, G, M	1, 3
6–8	*Koeleria lobata* (Syn. K. brevis)	Blue hair grass	4″	T–UN	S, N, RG	1
6–9	*Koeleria glauca*	Large blue hair grass	1′	T–UO	S, G, M, RG	1, 4, 7
5–9	*Melica ciliata*	Hairy melic grass	1–2′	T	S, PSh, G	1, 7
4–9	*Melica transsilvanica*	Transylvanian melic grass	1–2′	T	S, PSh, G	4, 7
7–9	*Milium effusum*	Wood millet	2′	T	PSh, G, DF	1
7–9	*Milium effusum aureum*	Golden wood millet	2′	UO	PSh, G, DF	1, 7
6–9	*Miscanthus sinensis*	Eulalia	6–8′	UO	S, PSh, G, M, N, S, DF	1
6–9	*Miscanthus sinensis* 'Gracillimus'		5–8′	UA	S, Sp, G, DF	1, 8
7–9	*Miscanthus sinensis purpurascens*		3–4′	UN–UO	S, Sp, G, DF	1, 8
6–9	*Miscanthus sinensis* 'Variegatus'	Variegated eulalia	5–7′	UO	S, PSh, S, G, MS, DF	1
6–9	*Miscanthus sinensis* 'Zebrinus'	Zebra eulalia	6–8′	UN–UO	S, Sp, G, MS, DF	1, 3, 8
4–9	*Molinia caerulea* 'Variegata'	Variegated purple moor grass	2′	T–UA	S, PSh, G, M, GC, RG	1, 3, 8
9–10	*Oplismenus birtellus* 'Variegatus'	Ribbon grass	2–3′	OS	S, GC	5
5–9	*Panicum clandestinum*	Deertongue grass	3–4′	UN	PSh, MS	1
5–9	*Panicum virgatum*	Switch grass	5–8′	UN	S, G, M, Sc FC, DF, N	1
5–9	*Panicum virgatum* 'Rotstrahlbusch'	Red switch grass	3–4′	UN	S, MS, G	1
5–9	*Panicum virgatum strictum*	Tall switch grass	5–6′	UN–UA	S, MS, G	1
6–9	*Pennisetum alopecuroides*	Fountain grass	3–4′	M	S, G, M, DF	1
7–9	*Pennisetum orientale*	Orient fountain grass	2–3′	T	S, G, M	1
4–9	*Phalaris arundinacea picta* (Syn. P.a. variegata)	Ribbon grass, gardener's-garters	2–3′	UO	S, PSh, M, G	1
4–8	*Schizachyrium scoparium* (Syn. Andropogon scoparius)	Little blue stem	3′	UA–UN	S, G, M	1
6–9	*Sorgbastrum nutans* (Syn. S. avenaeum)	Indian grass	4–6′	UO	S, G, M, N FC, DF	1, 2, 4
5–9	*Spartina pectinata*	Prairie cord grass	4–6′	UA–UO	S, MS, E, G, M, N	1
5–9	*Spartina pectinata* 'Aurea Variegata'	Variegated cord grass	5–7′	UA–UO	S, MS, FC, G, M, DF	1, 3
7–10	*Stenotaphrum secundatum* 'Variegatum'	Striped St. Augustine grass	3–12″	OS	S, GC, RG	5
6–9	*Stipa capillata*	Feather grass	3–4′	UO	S, DS, G, DF	1, 6
7–9	*Stipa gigantea*	Giant feather grass	4–6′	T	S, Sp, G	1, 8
7–9	*Stipa pennata*	European feather grass	4–5′	UO	S, DS, G, DF	1, 4, 7
7–9	*Themeda triandra* 'Japonica'	Japanese themeda	4–5′	UN	S, Sp, G, FC	1

A Problem with Pampas Grass

Recently a letter to an English gardening magazine asked: When is the best time to dig up and move a large pampas grass and how do you do it?

The surprising answer was: The best time is during the winter. Before digging up the plant, remove as much of the old foliage as possible. The traditional method is to light a small bonfire in it to burn it off. Screwing up several sheets of newspaper beneath the plant should provide sufficient heat and flame to burn off all the top growth. Then simply lift the roots with as much soil as possible and replant. It can also be divided if you wish.

Sources for Ornamental Grasses

The list (pp 96-99) covers the majority—but not all—of the ornamental grasses available to today's gardener. For additional sources of seeds of the more unusual grasses (including rushes, sedges, and grass look-a-likes) gardeners are advised to join the various rock garden societies including:

The American Rock Garden Society
15 Fairmead Rd., Darien, CT 06820

The Scottish Rock Garden Club
21 Merchiston Park, Edinburgh, EH10 4PW, Scotland, U.K.

The Alpine Garden Society
Lye End Link, St. John's, Woking, Surrey, England

The Royal Horticultural Society
Vincent Square, London SW1P 2PE U.K.

And the following additional firms for seeds:

Chiltern Seeds, Bortree Stile, Ulverston, Cumbria U.K. LA12 7PB.
Stock Seed Farms, Inc., R.R. #1, Box 112, Mursock, Nebraska 68407.
Thompson & Morgan, P.O. Box 1380, Jackson, New Jersey 08527.

and additional sources of plants:

Garden Place, 6780 Heisley Road, P.O. Box 83, Mentor, OH 44060.
Prairie Nursery, P.O. Box 365, Westerfield, WI 53964
Tripple Brook Farm, 37 Middle Road, Southampton, MA 01073
Sandy Mush Herbs, Rte. 2, Surrett Cove Road, Leicester, NC 28748.

Alopecurus pratensis *'Roseus', meadow foxtail, planted next to a brick walkway at Longwood Gardens adds a graceful, soft touch. Grow in full sun, or part shade in well-drained soil.*

Drawing by Peter Loewer

Bamboos at Brooklyn Botanic Garden

October 1988

Scientific Name	Common Name	C = Clumping R = Running Habit	Location
Arundinaria variegata		R	Bonsai Nursery
Arundinaria viridistriata		R	Bonsai Nursery
Bambusa 'Chinese Golden Bamboo'		C	Greenhouse
Bambusa glaucescens var. *riviereorum*	Chinese-goddess bamboo	C	Aquatic Greenhouse
Bambusa tuldoides	Punting-pole bamboo	C	Tropical Greenhouse
Bambusa vulgaris	Common bamboo	C	Greenhouse
Bambusa vulgaris 'Vittata'	Jade-striped golden bamboo	C	Conservatory Entry
Phyllostachys sp.*	Phyllostachys (bamboo)	R	Witch-hazel Island
*Phyllostachys arcana**	Phyllostachys (bamboo)	R	Japanese Garden
Phyllostachys aurea	Golden bamboo	R	Greenhouse
*Phyllostachys aureosulcata**	Yellow-groove bamboo	R	Japanese Garden
*Phyllostachys bissetii**	David Bisset bamboo	R	West Conifer Collection
*Phyllostachys flexuosa**	Zigzag bamboo	R	Japanese Garden
*Phyllostachys nidularia** 'Smooth-sheath'*	Broom bamboo	R	Japanese Garden
*Phyllostachys nigra**	Black bamboo	R	Greenhouse; SE Oak Circle
*Phyllostachys nuda**	Phyllostachys (bamboo)	R	Japanese Garden
*Phyllostachys rubromarginata**	Phyllostachys (bamboo)	R	Japanese Garden
Pleioblastus chino var. *viridis f. humilis**	Azuma-Nezasa (bamboo)	R	SE Oak Circle
*Pleioblastus variegatus**	Dwarf whitestripe bamboo	R	Japanese Garden
*Pseudosasa japonica**	Arrow bamboo or Metake	R	West Willow Area
Pseudosasa japonica var. *tsutsumiana**	Arrow bamboo (cultivar)	R	SE Oak Circle
*Sasa veitchii** 'Nana'*	Yakibazasa (bamboo)	R	Japanese Garden
*Shibataea kumasasa**	Ruscus-leaved bamboo	R	Japanese Garden

*BBG is in Zone 7 (USDA Hardiness Zone Map), low temperature Zero degrees F.

Bamboos Recommended for Bonsai

Chimonobambusa marmorea (kanchiku)
Pleioblastus pygmaeus (oroshimachiku)
Pseudosasa japonica (yadake)
Sasa palmata nebulosa (shakotanchiku)
Sasa veitchii (kumazasa)

Larger Bamboos for Pots

Bambusa multiplex (horaichiku)
Phyllostachys aurea (hoteichiku)
Phyllostachys nigra (kurochiku)
Semiarundinaria fastuosa (narihiradake)

Carex pendula *is one of the most graceful of the sedges. Grow in fertile soil in sun or part shade. Best grown as a specimen plant.*

Grasslike plants

Kerry Barringer

In addition to the hundreds of grasses in cultivation, there are a few plants that look like grasses, but are not. Blue-eyed grass, *Sisyrinchium,* is in the iris family, onion grass, *Allium,* is a true onion, pin grass, *Erodium cicutaria,* is a relative of the geraniums, and starry grass, *Cerastium arvense,* is a relative of the carnations. There are many more. It is usually easy to tell these plants from the true grasses by their showy flowers, but plants in the sedge family, Cyperaceae, and the rush family, Juncaceae, also have inconspicuous flowers and can be difficult to tell from grasses. A few of the species in these families are in cultivation. Because of their preference for wet or waterlogged soil, they are used along ponds and in damp wildflower gardens as well as in aquaria.

The sedges have stems that are triangular in cross-section and you can feel the angles if you roll the stems between your fingers. In contrast, the grasses have rounded stems. On some sedges, the angles are slightly rounded and can be difficult to distinguish. If this is the case, you must look at the lower part of the leaf, called the sheath, that clasps the stem. Sedges have sheaths that are closed tubes while grasses have sheaths that are slit along one side. You can gently pull a blade of grass so that the sheath comes away from the stem, but no amount of tugging will separate a sedges' sheath without tearing it.

Some of the sedges are popular water garden plants. The umbrella sedge, *Cyperus alternifolius,* is a native of Africa and Madagascar. It has a brushlike clusters of leaves and flowering branches borne at the top of slender stems. The papyrus, *Cyperus papyrus,* and its dwarf relative, *Cyperus isocladus,* can form dramatic clumps but must be watched because it can spread rapidly by underground stems.

Though seldom planted, the species of *Carex* can be attractive along the edges of ponds and in wildflower gardens. Species like the European *Carex pendula* and the native *Carex crinita* have lovely pendent spikes borne at the top of gently arching stems. The evergreen *Carex plantaginea* can be an interesting rock garden subject with its broad leaves and its purple-bracted flower stalks and the white-striped leaves of *Carex morrowii* var. *expallida,* the Japanese sedge, can add an unusual touch to borders.

The rushes, all in the genus *Juncus,* have small onionlike flowers but their petals and sepals have the color and texture of grass leaves. Very few are grown. They usually have wiry stems with a few thin leaves at the base and a few flowers near the top. Like the sedges, most species prefer wet, shady sites.

The Japanese-mat rush, *Juncus effusus,* is intensively cultivated in Japan where it is used to weave the tatami mats that are the usual floor covering in Japanese homes. *Juncus tenuis,* the path rush, is often an unwelcome guest in gardens but the species is remarkable for its toughness and tenacity. The path rush is often the only plant growing in paths and parking lots where the soil is constantly being trampled or compressed. It adds a little green to even the most desolate sites. The wood rush, *Luzula campestris,* is a broad-leaved relative of the rushes that is sometimes used in wildflower gardens. This clump-forming perennial has stems and leaves covered with long, white hairs. Plants reappear early in the spring and reach their full growth before leaves appear on the trees.

There are thousands of species of sedges and rushes growing wild in the world. They are usually overlooked as garden subjects, but they thrive in the damp shady areas that other species shun and can be useful in the poorly-drained corner of the garden where an interesting or unusual accent is sought.

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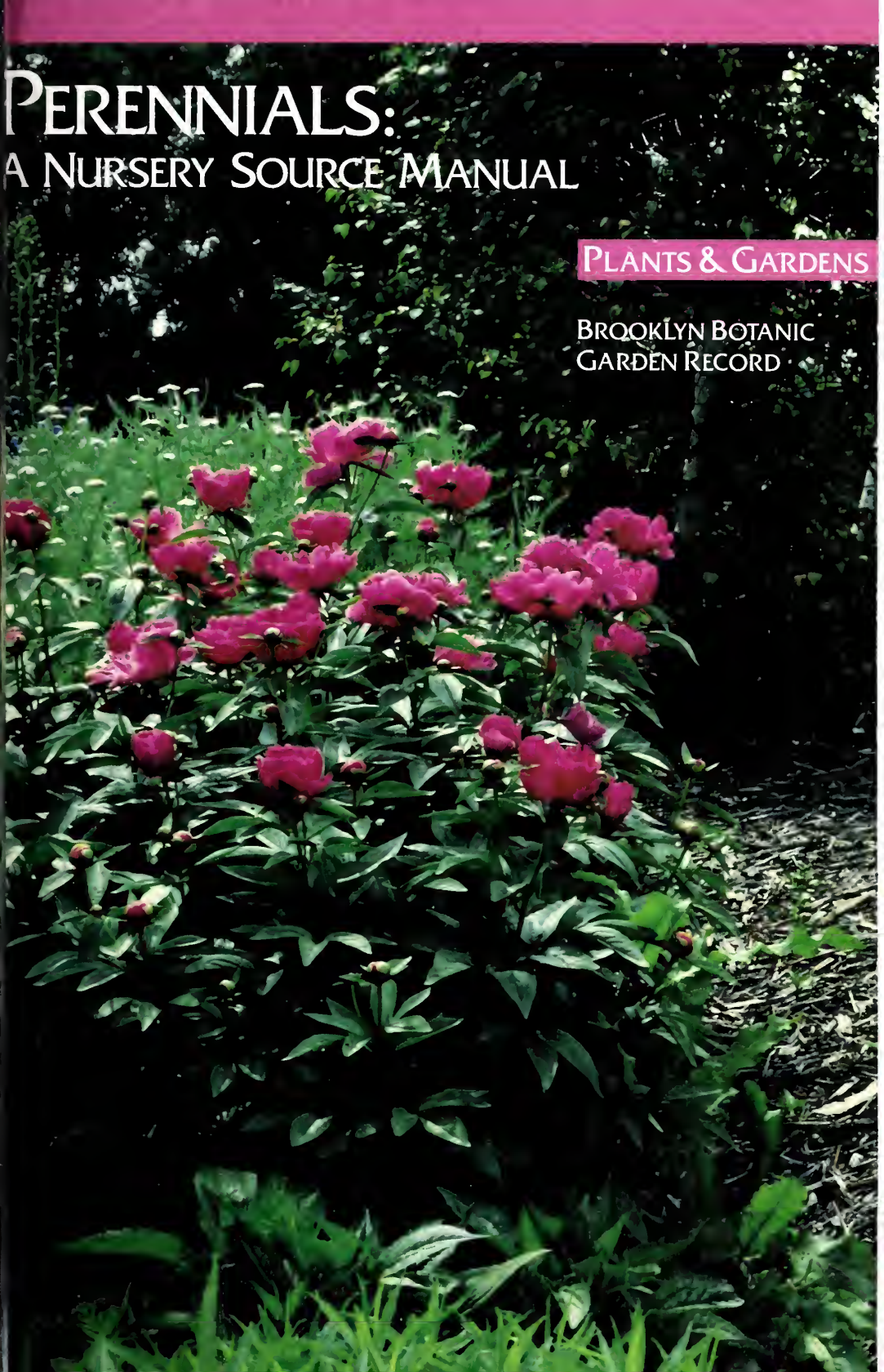
A NURSERY SOURCE MANUAL



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Perennials: A Nursery Source Manual

1989

Brooklyn Botanic Garden

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PLANTS & GARDENS
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Perennials: A Nursery Source Manual

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An old-fashioned perennial border of peonies, iris and delphinium
Cover photograph by Elvin McDonald

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foreword

This handbook follows a long tradition at the Brooklyn Botanic Garden—one that began in 1969 with the publication of the first nursery source manual compiled by Fred McGourty. That handbook contained descriptions and sources for woody plants and was revised a number of times.

With the age of computers and the ease of updating once original text is input, it seemed timely to produce a nursery source handbook on *perennials.* This enormous task would not have been possible without the tenacity of Nancy Gorkin, guest editor.

Perennials: A Nursery Source Manual provides the information needed to find the usual and the unusual candidates to fill most gardeners needs.

The Brooklyn Botanic Garden does not endorse any of the nurseries listed. This handbook was compiled as a reference for our members and the interested public.

Our wishes for a good gardening year.

Barbara B. Pesch

How To Use This Manual

The following paragraphs explain designations used in the plant listings. In order to list as many plants as possible, it was necessary to be brief with plant descriptions.

BOTANICAL NAMES only were used when listing the plants. For common names refer to the reference books listed in the bibliography. When a name appears in parentheses, it refers to a species synonym (e.g., *Sedum stenopetalum, [douglasii]).* The plant may be listed in some catalogs as *Sedum stenopetalum* or *Sedum douglasii.* In either case, they are the same plant. If a plant has an "x" in between the two names, it means that it is a hybrid of two species. The names listed in single quotations refer to cultivars of the various species. The names listed beneath a species, but not in single quotes, are naturally occurring varieties. The sources used to check correct nomenclature include *Hortus Third* and the *Andersen Horticultural Library's Source List of Plants and Seeds.*

THE HEIGHT (HT) given refers to the plant's height in bloom, except where noted. This will vary depending upon how much sun, water and fertilizer the plant receives.

SEASONS OF BLOOM refer to the New York metropolitan area (USDA Map Zone 8, Arnold Arboretum Map Zone 7).

NUMBER CODES following plant descriptions refer to the nurseries that carry that plant. The nursery list is located near the back of the manual. Nurseries which carry specific types of plants (i.e., dahlias, ferns, etc.) are also listed near the back of the manual, but have not been cross —referenced in this book. The dates following most nursery entries refer to the date of founding.

HARDINESS ZONES have not been listed because this information for herbaceous plants is very sketchy. If a plant is listed as being tender, it means that it is not reliably hardy above Zone 8 (USDA Map) and Zone 7 (Arnold Arboretum Map). For more information, you may wish to contact M. Larochelle, Route 2, Box 265 B, Asheville, NC 28805 who has just published the *Zone Finder* which lists the hardiness zones for 6000 types of herbaceous plants.

Acknowledgements

I would like to thank the following people for assisting me with the compilation of this manual: Rose Marie Blake who helped me get started, Bonnee L. Pecquex and Alan Gorkin who assisted in checking nomenclature, Barbara Pesch for allowing me to tackle this project and for gently prodding me toward its completion and finally to Alan Rosen who researched and wrote all of the plant descriptions and without whom this manual would never have been completed.

Nancy Kline Gorkin
2/22/89

Abelmoschus manihot—6′ HT, yellow, green coarse flowers in summer, tender. 181

Acaena buchananii—83

Acaena caesiiglauca—6″ HT, yellow flowers in summer, blue-green toothed leaves, evergreen. 98

Acaena magellanica (glaucophylla)—83

Acaena microphylla—2″ HT, red flowers in summer, evergreen bronze toothed leaves. 159, 161

'Kupferteppich'—83

Acantholimon araxanum—6″ HT, pink flowers in summer, silver, evergreen rosettes, requires good drainage. 133, 145

Acanthus balcanicus—4′ HT, rose-purple flowers in summer, white and dark green leaves. 91

Acanthus mollis—4′ HT, rose-purple flowers in summer, white and dark green leaves. 165

'Latifolius'—larger leaves than above. 37, 159

Acanthus spinosissimus (spinosus)—3′ HT, lilac, rose and white flowers in spring and summer. 29

Achillea ageratifolia—8″ HT, white flowers in summer, silvery pubescent leaves. 9, 133, 145

Achillea chrysocoma—6″ HT, golden yellow. 145

Achillea clavennae (argentea)—7″ HT, white flowers in summer, silky gray toothed leaves. 98, 137, 145, 159, 161

Achillea coarctata—3′ HT, bright golden flowers in summer, gray-green woolly leaves. 183

Achillea filipendulina—4′ HT, yellow flowers in summer, lacy gray-green leaves. 5, 33, 69

'Cloth of Gold'—4′ HT, golden flowers in summer, gray-green lacy leaves. 115, 183

'Coronation Gold'—3′ HT, yellow flowers in summer, good for drying, gray-green lacy leaves. 9, 37, 39, 49, 67, 77, 91, 95, 159, 165, 169, 177

'Gold Plate'—5′ HT, mustard-yellow flowers in summer, lacy green leaves. 9, 37, 45, 165

'Moonshine'—2′ HT, bright yellow flowers in summer, lacy gray-green leaves. 9, 27, 29, 34, 37, 39, 49, 77, 91, 157, 159, 165, 169, 175, 177

'Parker's Gold'—3′ HT, lacy light green leaves. 37, 49, 91, 159, 161, 175

Achillea millefolium—1.5—2′ HT, white flowers in summer, gray lacy leaves. 113, 115, 117, 120, 123, 157

'Appleblossom'—171

'Cerise Queen' (Cherry Queen)—2′ HT, cerise flowers with white eyes, feathery green leaves. 3, 49, 75, 115, 183

'Crimson Beauty'—crimson flowers. 9

'Fire King'—bright red flowers. 34, 95

'Great Expectations'—144, 171

'Heidi'—1.5′ HT, reddish-pink flowers. 9

'Hoffung' (Hope)—antique yellow flowers. 9

'Kirschkongin'—52

'Lilac Beauty'—1.5′ HT, pinkish-lilac flowers. 34

'Paprika'—1.5′ HT, hot pink flowers. 9, 91

'Red Beauty'—1.5′ HT, crimson-red flowers. 27, 37, 49, 77, 159, 169, 175, 177

roseum—1.5′ HT, rose-pink flowers. 9, 37

'Rose Beauty'—1.5′ HT, rose flowers. 183

'Rosy Red'—1.5′ HT. 161

'Salmon Beauty'—171

'The Beacon'—171

'White Beauty'—pure white flowers. 9, 34, 37, 49, 169

Achillea ptarmica—invasive. 69

'Angel's Breath'—same as 'The Pearl' only flowers are larger and last longer. 9, 27, 49, 165

'Ballerina'—2′ HT, white flowers in summer, lacy gray-green leaves. 175

'The Pearl'—2′ HT, double white flowers in summer, green, smooth leaves. 37, 75, 159, 161, 165, 169, 177, 183

'Perry's Giant White'—2′ HT. 37

Achillea ptarmicifolia—2′ HT, same as *A. ptarmica* with flowers half the size. 183

Achillea serbica—97

Achillea taygetea—2′ HT, lemon-yellow flowers in summer, ferny gray-green leaves. 34, 37, 69, 165

Achillea tomentosa—6″ HT, yellow and white flowers in summer, woolly silver foliage. 9, 33, 37, 49, 98, 177, 183

'Aurea'—10″ HT, canary-yellow flowers. 3, 37, 49, 77, 159, 183

'King Edward VII'—6″ HT, primrose-yellow flowers in summer, woolly silver foliage. 3, 37, 49, 77, 159, 183

'Maynard Gold'—rich yellow flowers. 37, 133

'Nana'—4″ HT, deep yellow flowers. 37

Achillea umbellata—6″ HT, white flowers in summer, woolly silver foliage.

Achillea 'Utah'—1″ HT, white ferny foliage. 133

***Acidanthera** murieliae*—171

***Aethionema** armenum*—6″ HT, light pink flowers in spring, blue-green foliage. 49

Aethionema cordifolium (jucunda)—10″ HT, creamy-white or pale pink flowers in spring, green fleshy leaves. 49, 159, 161, 165, 169, 175

'Warley Rose'—6″ HT, rose-pink flowers. 37, 49, 133, 137, 145, 159

Aethionema grandiflorum—1′ HT, blooms in summer. 109, 159, 175

Aethionema schistosum—4″ HT, pink flowers in summer. 95

***Agave** utahensis*—1′ HT, yellow 6′ scapes in summer, succulent gray-green leaves, requires excellent drainage. 145

***Alcea** ficifolia (Althaea ficifolia)*—6′ HT, pastel flowers in summer, broad coarse foliage, a short-lived perennial. 9, 107, 159, 161

Alcea pallida—52

Alcea rosea—6′ HT, short-lived perennial. 33, 159

'Chamois'—double chamois-colored flowers. 159

'Chater's Double Mix'—powder puff mix. 67, 159, 169, 177

'Cherry Red'—cherry-red pom-pom flowers. 159

'Farmyard Strain'—single mix. 37, 77

'Fordhook Giants'—double mix. 27

'Marjorette'—2′ HT, mix. 175

'Newport'—83, 153

'Nigra'—rich maroon flowers with black center. 37, 159, 175

'Powderpuffs'—5′ HT, double mix. 37, 69, 175, 177

'Southern Belle'—2.5′ HT, red, pink and white flowers. 33

'Zebrina'—3′ HT, lavender flowers, fragrant. 175

***Alchemilla** alpina*—4″ HT, chartreuse flowers in spring, scalloped hairy leaves. 9, 34, 49, 95, 145, 159

Alchemilla erythropoda—8″ chartreuse flowers in spring, green scalloped flowers. 34, 49, 77, 159

Alchemilla glaucescens (pubescens)—8″ HT, chartreuse flowers in spring, rounded blue-green leaves. 9, 37, 91, 159

Alchemilla x *splendens*—10″ HT, green flowers, leaves deep green with silver edges and underside.

Alchemilla vulgaris (mollis) —8″ HT, chartreuse flowers in spring, scalloped blue-green leaves. 9, 29, 33, 37, 39, 49, 69, 77, 91, 95, 143, 145, 157, 159, 165, 169, 175, 177, 183

'Auslee'—65, 153

Alpinia *japonica*—1.5′ HT, white flowers with yellow markings in summer, broad leaves. 54, 173

Alstroemeria *aurantiaca*—3′ HT, yellow-orange flowers in summer, glaucous foliage. 139, 173

Alstroemeria ligtu—4′ HT, rose, salmon, pink and red flowers in summer, tender. 49

Alstroemeria psittacina (pulchella)—3′ HT, dark red flowers with green and brown spots in summer. 109, 145, 173

Alyssoides *utriculata*—1.5′ HT, fragrant yellow flowers in summer. 49

Alyssum *cuneifolium*—6″ HT, yellow flowers, gray tufted leaves. 133

Alyssum montanum— 4″ HT, sulphur-yellow flowers in spring, small oval gray leaves. 3, 133, 159, 183

'Berrgold'—6″ HT, golden-yellow fragrant flowers. 161

Alyssum murale (argenteum)—1.5′ HT, golden-yellow flowers in spring, gray-green leaves. 159, 183

Alyssum serpyllifolium—6″ HT, bright yellow flowers in spring, gray leaves. 9

Amsonia *ciliata*—3′ HT, blue flowers in spring. 181

Amsonia hubrectii—2.5′ HT, grown for its needlelike foliage and yellow fall color. 181

Amsonia illustris—2′ HT, blue flowers. 29, 139

Amsonia ludoviciana—2′ HT, pale blue flowers, felt backed leaves. 181

Amsonia tabernaemontana—3.5′ HT, blue flowers in spring, green lance-shaped leaves turning yellow in fall. 9, 29, 37, 49, 61, 77, 91, 115, 117, 143, 157, 159, 165, 173, 177, 181

salicifolia—3′ HT, leaves thinner and longer. 37, 159, 181

texana—91

Anacyclus *depressus*—6″ HT, white flowers with purple on back of petals in summer, succulent ferny foliage, requires good drainage. 3, 37, 61, 137, 145, 159, 165, 169

Anagallis *monelli*—1.5′ HT, flowers blue with red beneath in summer, tender. 61

Anaphalis *margaritacea*—3′ HT, white flowers with a yellow eye in summer, narrow gray woolly foliage, requires moisture. 33, 69, 120, 159

'New Snow'—171

Anaphalis triplinervis—1.5′ HT, white flowers with a yellow eye in summer, gray woolly foliage, requires moisture. 67, 177

'Sulphur Light'—pale yellow flowers with deeper yellow center. 37

'Summer Snow'—171

Anaphalis yedoensis (cinnamomea)—2′ HT, white flowers with a yellow eye in summer, leaves green felted on the undersides. 37, 95

Anchusa *azurea (italica)*—5′ HT, light blue flowers in spring, coarse hairy foliage. 3

'Dropmore'—deep blue flowers. 37, 159, 177

'Little John'—1.5′ HT, deep blue flowers. 9, 29

'Loddon Royalist'—deep blue flowers. 27, 29, 159

'Royal Blue'—deep blue flowers. 37

Androsace carnea—requires excellent drainage

'Alba'—1″ HT, white flowers in summer, tufted green foliage. 133

brigantiaca—2′ HT, pale pink flowers in spring, needlelike foliage. 145

Androsace lactiflora—121

Androsace lanuginosa—6″ HT, lavender-pink flowers with a white eye in summer, silvery foliage. 133, 145

Androsace primuloides

'Chumbyi'—2″ HT, pink flowers in spring, silvery rosettes. 95, 133

'Yunnanense'—2″ HT, pink-lavender flowers in spring, larger silvery rosettes. 133

Androsace sarmentosa—5″ HT, light pink flowers in spring, silvery rosettes. 95, 145

sherriffii—5″ HT, pink flowers in spring, longer leaves.

Androsace sempervivoides—3″ HT, pink flowers in spring, green rosettes. 95, 145

Androsace strigillosa—1′ HT, white flowers with purple backs in spring, felted rosettes. 145

Androsace villosa jacquemontii—2′ HT, similar to *A. sarmentosa* but smaller. 145

Anemone alpina sulphurea—1.5′ HT, yellow flowers in spring, fernlike foliage. 49

Anemone baldensis—4″ HT, white flowers in spring. 3, 161

Anemone canadensis—1.5′ HT, white flowers in spring, requires moist soil. 25, 37, 120, 127, 139

Anemone caroliniana—1′ HT, purple, pink and white flowers in summer. 3

Anemone cylindrica—3′ HT, white flowers in summer, ornamental fluffy seed pods. 127, 183

Anemone flaccida 'Japan'—4″ HT, cream white flowers in summer. 11

Anemone montana—5″ HT, dark violet flowers in spring. 3

Anemone multifida—2′ HT, white flowers. 161

Anemone patens—8″ HT, pastel blue flowers in spring, fluffy white seedheads, ferny green leaves. 127

Anemone pulsatilla—1′ HT, red, purple, lilac flowers in spring, ferny green foliage, fluffy seedheads, requires good drainage. 3, 9, 25, 29, 33, 49, 61, 75, 95, 139, 143, 159, 161, 165, 169, 177

'Alba'—white form. 25, 145, 159, 161, 169, 177

'Red Bell'—light red flowers. 161

'Rubra'—dark red. 29, 37, 143, 145, 159, 169, 177

'White Swan'—white flowers. 95

Anemone quinquefolia—1′ HT, white, pink, crimson flowers in summer. 120

Anemone rivularis—1.5′ HT, white flowers with a bluish center in spring. 3, 29, 37, 49, 61, 95, 133, 143, 145, 159, 165, 169

Anemone vernalis—6″ HT, white, violet flowers in spring, evergreen. 161

Antennaria 'Devil's Tower'—4″ HT, pink flowers in spring, gray-green leaves edged in white, evergreen. 145

Antennaria dioica (tomentosa)—10″ HT, white flowers in spring, green leaves with white on the undersides, evergreen, stoloniferous. 67, 98

'Minima Rubra'—2″ HT, pink flowers, silvery green leaves. 145

'Nyewood'—3″ HT, cherry-red flowers, silvery leaves. 145

'Tomentosa'—woolly leaves. 9, 49, 67

Antennaria parvifolia (aprica)—6″ HT, white and pink flowers in summer, silvery woolly leaves, evergreen, stoloniferous. 133

Antennaria plantaginifolia—10″ HT, gray-white flowers in spring, woolly white leaves, evergreen. 49

Antennaria rosea—1′ HT, same as Antennaria dioica except flowers are pink or rose. 9, 54, 61, 95, 159

Antennaria suffrutescens—5″ HT, white flowers in summer, green, silver-backed leaves. 145

Anthemis *cupaniana*—1′ HT, pure white flowers in summer, dissected gray foliage, requires excellent drainage. 34, 95

Anthemis marschalliana (biebersteiniana)—1′ HT, yellow flowers in summer, gray ferny foliage, requires excellent drainage. 37, 95, 133

Anthemis montana—10″ HT, white flowers in summer, gray pubescent leaves,requires excellent drainage. 97

Anthemis sancti-johannis—2′ HT, orange-yellow flowers in summer, gray ferny foliage, requires excellent drainage. 37, 75, 159, 183

Anthemis tinctoria—3′ HT, yellow flowers in summer, parsleylike green leaves. 69, 109

'Beauty of Grallagh'—golden-orange flowers. 34, 37, 159

'E.C. Buxton'—lemon-yellow flowers. 9, 95, 175

'Kelwayi'—golden-yellow flowers. 9, 95, 175

'Moonlight'—pale yellow flowers. 9, 37, 95

'Pale Moon'—light canary flowers which fade to ivory. 37, 95

Anthemis 'Wargrave'—creamy-yellow flowers. 34

Anthericum *liliago*—2′ HT, white flowers in summer, grassy green leaves. 11, 95

Anthericum ramosum—2.5′ HT, white flowers in summer smaller than *A. liliago*. 34, 49, 95, 109

Aquilegia *canadensis*—1′ HT, red/yellow flowers in late spring. 3, 9, 25, 29, 37, 61, 66, 77, 109, 113, 115, 117, 120, 123, 127, 139, 143, 157, 159, 161, 173, 177, 181

'Corbett'—1′ HT, pale yellow flowers in summer. 109

'Nana'—10″ HT, compact form of species. 143

Arabis *alpina*—1′ HT, white flowers. 33

'Coccineum'—153

'Flore Pleno'—65, 83, 153

'Pink Pearl'—1′ HT, pink, fragrant flowers. 183

'Rosea'—83

'Variegata'—8″ HT, white flowers, leaves with white margins. 137

Arabis androsacea—3″ HT, white flowers in spring, silvery rosettes of leaves, requires excellent drainage. 49, 145

Arabis blepharophylla—10″ HT, rose-purple fragrant flowers. 109

'Spring Charm'—10″ HT, reddish-purple fragrant flowers. 145, 159, 161, 169

Arabis caucasica (albida)—8″ HT, white flowers in spring, evergreen. 33, 95

'Compinkie'—5″ HT, pink flowers. 49, 159, 161, 183

'Coccineum'—6″ HT, rose-red flowers. 37, 95, 133

'Flore Pleno'—double white flowers. 9, 49, 133, 177

'Fragrant Cloud'—3

'Snowball'—6″ HT, pure white flowers. 3, 161

'Snow Cap'—pure white flowers. 3, 9, 49, 143, 161, 169, 175, 177, 183

'Snowflake'—52

'Spring Charm'—8″ HT, rose pink. 97, 137, 143, 175

'Variegata'—white flowers, leaves with white margins. 37, 49, 95, 145

Arabis ferdinandi-coburgi—3″ HT, white flowers in spring, evergreen rosettes. 98

'Variegata'—leaves edged with white. 9, 27, 37, 49, 95, 109, 133, 145

Arabis x *kellereri*—3″ HT, white flowers in spring, ashy gray evergreen rosettes. 133

Arabis procurrens—8″ HT, white flowers in spring, evergreen. 37, 77, 109, 133, 159, 161

Arabis pumila—121

Arabis 'Rosabella'—5″ HT, rose-pink flowers, evergreen. 177

Arabis soyeri jaquinii—20″ HT, white flowers, dark green lance-shaped leaves. 161

Arabis stelleri japonica—1′ HT, white flowers in spring, evergreen rosettes. 173

Arabis sturii—8″ HT, white flowers, compact version of *A. procurrens*. 37, 95, 145, 159

Aralia nudicaulis—1′ HT, greenish white flowers in late spring, green divided leaves. 120

Aralia racemosa—3′ HT, greenish white flowers in summer, large divided heart-shaped leaves. 66, 120

Arenaria kingii—6″ HT, white flowers in spring. 49

Arenaria laricifolia (Minuartia larcifolia)—8″ HT, white flowers in summer. 3, 161

Arenaria montana—4″ HT, white flowers in summer, dark green leaves. 37, 133, 143, 145, 159, 161, 169

Arenaria procera glabra—6″ HT, white flowers in summer, spiny grass tufts. 52, 159

Arenaria tetraquetra—3″ HT, white flowers in summer. 145

granatensis—4″ HT, white flowers, more condensed form. 145

Arenaria verna (caespitosa)—4″ HT, white flowers in summer, mosslike green leaves. 3, 9, 95

'Aurea'—same as species only leaves yellow-green. 3, 9, 27, 37, 49, 67, 95, 133

caespitosa—compact form of species. 37, 159

Armeria juncea (setacea)—10″ HT, pink flowers in summer. 11, 95

'Alba'—white flowers. 95

Armeria juniperifolia (caespitosa)—3″ HT, lavender-pink flowers in early summer. 145

'Alba'—white flowers. 3, 95, 133, 145

'Bevan's Variety'—5″ HT, deep rose flowers. 3, 133, 137, 145

Armeria maritima (laucheana and *sundermanii)*—10″ HT, scape pink, purple and white in late spring. 3, 63, 91, 98, 109, 137

'Alba'—10″ HT, white flowers. 9, 13, 33, 37, 49, 77, 91, 133, 159

'Bloodstone'—10″ HT, intense blood red. 37

'Brilliant'—10″ HT, intense blood red. 37

'Dusseldorf Pride'—10″ HT, deep rose-wine flowers. 29, 37, 49, 91, 95, 133, 165

'Jewel'—95

'Laucheana'—8″ HT, deep rose-pink. 27, 37, 77, 159, 165

'Merlin'—8″ HT, soft pink. 133

'Splendens'—3

'The Pride'—3

'Vindictive'—1.5′ HT, brilliant rose-carmine. 9, 37, 165

Armeria 'Ornament'—1′ HT, white rose-pink flowers in summer, green grassy tufts of leaves. 3, 159

Armeria plantaginea—larger leaves than *A. maritima*

'Bee's Ruby'—1.5′ HT, brilliant rose-carmine flowers. 37, 95

'Royal Rose'—1.5′ HT, rose-pink flowers. 37

Armeria pseudarmeria (formosa and *cephalotes)*—1′ HT, white, pink and rose flowers in summer, resembles A. *maritima* but leaves larger. 9, 49, 115, 175, 183

'Rubra'—red flowers. 95, 159, 165

Arnica *acaulis*—2′ HT, yellow daisy flowers in spring, evergreen hairy foliage. 173

Arnica chamissonis—15″ HT, yellow flowers in spring. 161

Arnica longifolia—1.5′ HT, yellow flowers in summer. 161

Arnica montana—153

Artemisia *absinthium*—2.5′ HT, silky gray foliage. 37, 69, 98, 183

'Huntington Gardens'—4′ HT, larger than above. 37

Asclepias tuberosa

'Lambrook Silver'—foliage finer than species. 9, 34, 37, 95

Artemisia arborescens—4′ HT, filagree silvery foliage, tender. 98

Artemisia canescens (versicolor)—1.5′ HT, curled, lacy, filagree, silver foliage. 9, 34, 95, 98, 145, 159

Artemisia frigida—1.5′ HT, yellow flowers, leaves aromatic. 183

Artemisia lactiflora—5′ HT, white plumes in late summer, green jagged leaves. 34, 37, 49, 95, 159, 165

Artemisia ludoviciana (purshiana)—3.5′ HT, silvery grey willowlike leaves. 159

'Silver Bouquet'—49

'Silver Frost'—1.5′ HT, frosty green leaves with a silver underside. 37, 91, 165

'Silver King'—2.5′ HT, silvery white leaves, invasive. 9, 37, 49, 69, 95, 117, 127, 133, 159, 183

'Silver Queen'—2.5′ HT, broader foliage than 'Silver King', invasive. 9, 37, 49, 91, 159, 159, 183

Artemisia 'Powis Castle'—2.5′ HT, pewter-gray filigree leaves. 34, 37, 49, 98

Artemisia schmidtiana 'Silver Mound' ('Nana')—1′ HT, silver filigree mounds. 9, 21, 27, 37, 39, 49, 52, 63, 65, 67, 75, 77, 83, 91, 95, 97, 98, 107, 133, 144, 145, 153, 159, 165, 169, 175, 177, 183

Artemisia stellerana—1′ HT, felt-like gray-white leaves. 37, 49, 65, 83, 91, 95, 145, 159, 165, 183

Artemisia 'Valerie Finis'—2.5′ HT, gray-white jagged edged leaves. 34, 159

Artemisia viridis—3″ HT, soft green lacy rosettes, requires excellent drainage. 133, 145

Asarina *procumbens*—3″ HT, soft yellow flowers in summer, leaves dark green hairy and sticky, evergreen. 49, 98, 161

***Asclepias** incarnata*—4′ HT, pink flowers in summer, prefers damp soil. 9, 49, 109, 115, 117, 120, 127, 157

Asclepias rubra—144

Asclepias syriaca—4′ HT, lavender flowers in summer. 127

Asclepias tuberosa—2.5′ HT, red, yellow, orange flowers in summer, requires excellent drainage. 3, 9, 25, 29, 37, 39, 49, 66, 69, 77, 91, 113, 115, 117, 127, 139, 157, 159, 165, 169, 177, 181, 183

***Asphodeline** liburnica*—52

Asphodeline lutea— 2′ HT, yellow fragrant flowers in summer. 49, 159, 175

***Aster** x alpellus*—1′ HT, ray flowers blue with an orange center, a cross of *A. alpinus* and *A. amellus.*

'Triumph'—37, 153

Aster alpinus—10″ HT, blue to violet flowers in spring and summer. 115, 157, 161

'Albus'—white flowers. 33, 49, 133, 153, 159, 161

'Blue'—rich blue flowers. 91, 133

'Dark Beauty'—3, 153, 159, 161

'Goliath'—3, 107, 137, 161, 169

'Happy End'—rose flowers. 133, 161

Aster amellus—2′ HT, bluish-lilac flowers in autumn.

'Framfieldii'—9

'Rudolph Goethe'—159

Aster azureus—5′ HT, flowers deep blue to violet. 127

Aster concolor—2′ HT, violet flowers in fall, silky hairy leaves. 173

Aster dumosus—fall blooming

'Alert'—1′ HT, deep crimson red-flowers. 3, 169, 175

'Alice Haslam'—10″ HT, deep rosy-red. 29

'Lady in Blue'—10″ HT, blue flowers. 29

'Melba'—1′ HT, pink flowers. 3

'Niobe'—6″ HT, white flowers. 37, 145

'Royal Opal'—1′ HT, blue flowers. 3

'Snow Cushion'—8″ HT, white flowers. 3

'Trimix'—20″ HT, blue, lavender, rose and pink flowers. 161

'Violet Carpet'—10″ HT, rich violet-blue flowers. 145

'White'—10″ HT. 91

Aster ericoides (multiflorus)—3′ HT, white flowers in late summer. 34, 107, 127

'Cinderella'—1.5′ HT, improved form of species. 9

'Golden Spray'—83

'Ringdove'—2.5′ HT, lilac-rose flowers. 9

Aster x *frikartii*—2.5′ HT, lavender-blue flowers in summer and fall. 34, 37, 133, 159, 165, 175, 177

'Jungfrau'—lavender-blue flowers. 91

'Monch'—lavender-blue flowers, sturdier than 'Wonder of Staffa'. 9, 77, 91, 165, 169

'Wonder of Staffa'—lavender-blue flowers. 9, 27, 37, 95, 165

Aster 'Goldflake'—65, 153

Aster grandiflorus—3′ HT, large violet/bright yellow centers in fall. 54, 77, 173, 181

Aster laevis—4′ HT, pale blue flowers in late summer. 77, 120, 127, 165

Aster lateriflorus—2′ HT. 120

'Hortizontalis'—pale lilac flowers in fall, hortizontal branching. 9, 34

Aster linearifolius—1′ HT, pinkish-purple flowers in fall, fine foliage. 61, 77, 157, 173

Aster linosyris 'Gold Flake'—15″ HT, deep golden-yellow flowers in summer. 95

Aster macrophyllus—2.5′ HT, sky-blue flowers

in late summer, large heart-shaped leaves. 25

Aster novae-angliae—7′ HT, can be clipped to any height, favors damp, wet soils, blooms in fall. 3, 25, 37, 66, 115, 127, 157, 173

'Alba'—4′ HT, pure white. 37

'Alma Potschke'—3′ HT, rose-salmon tinged flowers. 9, 27, 37, 109, 133, 159, 177

'Barr's Pink'—4′ HT, clear pink flowers. 29, 37

'Ben's Select'—4′ HT, mix of colors. 3

'Blue Lake'—3′ HT, blue flowers. 27

'Fellowship'—3′ HT, pink flowers. 9

'Golden Sunshine'—153

'Harrington's Pink'—3′ HT, pink flowers. 9, 77, 109, 159, 165, 177

'Hella Lacy'—3′ HT, purple flowers. 9, 37, 109

'Honeysong Pink'—3.5′ HT, clear rich pink. 37

'Latest One'—4′ HT, blue flowers. 109

'Red Star'—4′ HT, carmine-red flowers. 29

'Rudelsburg'—83

'September Ruby'—4′ HT, ruby-red flowers. 9, 37, 95, 159, 165, 177

'Treasurer'—4.5′ HT, lilac-purple with a slight twist at the petal tip. 37, 77, 109, 159, 165, 177

'Wedding Lace'—65, 153

Aster novi-belgii'—all fall blooming. 54

'Ada Ballard'—3′ HT, semidouble lavender-blue flowers. 165

'Alert'—15″ HT, red flowers. 9, 37, 95, 159, 165

'Alice Haslam'—10″ HT, deep double rose-pink flowers. 37, 145, 159, 165

'Audrey'—1′ HT, lavender-blue flowers. 95, 165, 177

Aster novae-angliae

'Autumn Glory'—3′ HT, semidouble red flowers. 165

'Beechwood Rival'—3′ HT, wine-red flowers. 159

'Blue Baby'—83

'Blue Gown'—4′ HT, clear sky-blue flowers. 159

'Blue Lake'—3′ HT, medium blue flowers. 159

'Bonningale'—2.5′ HT, double white flowers. 159, 177

'Bonnie Blue'—10″ HT, wisteria-blue flowers. 37, 165

'Chorister'—1.5′ HT, white flowers. 37

'Coombe Violet'—4′ HT, violet-purple flowers. 177

'Constance'—1.5′ HT, double bright rose pink. 95

'Crimson Brocade'—3′ HT, red flowers. 9, 37, 39, 95, 159, 165, 177

'Eventide'—3′ HT, deep blue flowers. 9, 37, 95, 159, 165, 177

'Fellowship'—2.5′ HT, double pink flowers. 37, 95

'Finalist'—3′ HT, violet-blue flowers. 165

'Hein Richard'—8″ HT, red flowers. 37

'Jenny'—1′ HT, cerise-red flowers. 65, 83, 153, 159, 165, 177

'Kassel'—1′ HT, semidouble carmine flowers. 65, 153, 165

'Lady in Blue'—1.5′ HT, powder-blue flowers. 29, 83, 159

'Lamb's Pride'—2.5′ HT, large double rose-lavender flowers. 95, 153

'Little Boy Blue'—83

'Marie Ballard'—2.5′ HT, double powder-blue flowers. 37, 95, 83, 95, 153, 165

'Melba'—1′ HT, semidouble pastel pink flowers. 3, 37, 97, 171

'Mt. Everest'—3′ HT, white flowers. 9, 39, 65, 83, 95, 153, 159, 165

'Oktoberscheekupfel'—83

'Patricia Ballard'—3′ HT, pink flowers. 159, 177

'Peter Harrison'—1.5′ HT, clear pink flowers. 37, 159, 165

'Peter Pan'—37

'Pink Cameo'—15″ HT, clear pink flowers. 95

'Pink Bouquet'—1′ HT, pink flowers. 9, 37, 169, 183

'Plenty'—83

'Professor Kippenburg'—1′ HT, blue-violet flowers. 9, 27, 37, 77, 95, 133, 145, 159, 165, 169, 183

'Purple Giant'—4′ HT, dark purple flowers with an orange center. 95

'Purple Glory'—83

'Red Star'—1′ HT, rosy-maroon flowers. 37, 169, 183

'Romany'—8″ HT, rosy-violet flowers. 177

'Rose Serenade'—1′ HT, rose-pink flowers. 37, 169

'Rosenwichrel'—1′ HT, deep rose-pink. 37

'Royal Amethyst'—83

'Royal Opal'—10″ HT, ocean-blue flowers. 37, 95, 159, 165, 183

'Royal Ruby'—83

'Sailor Boy'—3′ HT, navy-blue flowers. 159

'Skylands Queen'—3′ HT, lavender-blue flowers. 37

'Snowball'—10″ HT, white flowers. 37, 95, 159

'Snow Cushion'—1′ HT, white flowers. 37, 169, 183

'Snow Flurry'—15″ HT, white flowers. 9, 37, 165, 177

'Snowsprite'—5″ HT, white flowers. 159

'Victor'—1′ HT, clear blue-lavender flowers. 37

'Violet Carpet'—10″ HT, deep violet-blue. 37, 133, 169

'White'—91

'White Fairy'—10″ HT, white flowers in late summer. 159

'White Opal'—1′ HT, white flowers. 37, 169

'Winston Churchill'—1.5′ HT, red flowers in summer. 159

Aster oblongifolius—2′ HT, light violet flowers in fall, requires excellent drainage. 113, 115, 157

Aster ptarmicoides—2.5′ HT, white flowers in late summer, requires excellent drainage. 127

Aster puniceus—5′ HT, pale blue flowers in fall, prefers moist soils. 66, 120, 173

Aster sedifolius 'Nanus'—3′ HT, blue flowers. 65, 83, 183

Aster 'Sneekissen'—8″ HT, white flowers in fall. 133

Aster spectabilis—3′ HT, violet-purple flowers, shallowly toothed leaves. 77

Aster tataricus—7′ HT, violet flowers in fall, large basal leaves. 37, 173, 181

Aster tibeticus—5″ HT, large purple-blue flowers in spring, tufted green leaves. 145

Aster tongolensis (subcoeruleus)—1.5′ HT, violet flowers with an orange center in summer, dark coarse leaves. 33, 63, 175

'Berggarten' (*A. farreri* 'Berggarten')—lavender-blue flowers. 159, 171

'Napsbury'—1.5′ HT, large lavender flowers. 177

'Wartburgstern'—1.5′ HT, violet-blue flowers. 159, 161, 169

Aster umbellatus—4′ HT, white flowers in late summer. 120, 173

Asteromea *mongolica (Boltonia mongolica)*—2.5′ HT, large white flowers in fall. 37, 49, 109, 117, 173, 181

Astragalus *alpinus*—2′ HT, dark purple flowers in summer, gray-green pealike foliage. 49

Astragalus canadensis—3′ HT, creamy yellow flowers in summer, ornamental seed pods. 127

Aubrieta 'Bengal'—4″ HT, mixed flowers. 3, 37, 159

Aubrieta 'Borsch's White'—white flowers. 95

Aubrieta 'Cascade Strain'—mix of soft pink to deep purple. 177

Aubrieta deltoidea (campbellii, hendersonii, leichtlinii)—3, 9, 49, 107, 161

'Giant Superbissima Mixed'—red violet and blue flowers. 133

gracea—light blue flowers. 3, 161

'Variegata'—blue flowers, gray-green leaves edged with white. 37, 95, 133

Aubrieta 'Dr. Mules'—dark royal-blue flowers. 95

Aubrieta gracilis—3″ HT, purple flowers, mounding habit. 145

Aubrieta 'Novalis Blau'—6″ HT, double medium blue flowers. 3, 9, 161

Aubrieta 'Manon Mix'—3

Aubrieta 'Purple Gem'—purple flowers. 9, 169

Aubrieta 'Red Cascade'—brilliant carmine. 3, 161

Aubrieta 'Royal Blue'—blue, lavender or violet shades 3, 159, 161

Aubrieta 'Royal Red'—magenta, red or purple flowers. 3, 159

Aubrieta 'Royal Velvet'—frilly rich violet-purple flowers. 95

Aubrieta 'Whitewell Gem'—dark purple. 37, 161

Aurinia *armenum*—10″ HT, yellow flowers in spring, requires excellent drainage. 183

Aurinia petraea (Alyssum petraeum)—122

Aurinia saxatilis (Alyssum saxatilis)—8″ HT, yellow flowers in spring, grayish leaves, evergreen. 3, 33, 37, 49, 91

'Citrina' ('Sulphureum')—soft yellow. 9, 37, 133, 159, 177

'Compacta'—37, 159, 161, 169, 177, 183

'Gold Dust'—bright yellow flowers. 37, 161

'Flore Plena'—double yellow flowers, silvery leaves. 9, 95, 177

'Silver Queen'—primrose-yellow flowers. 95

'Sunny Border Apricot'—apricot flowers, silvery leaves. 9, 95

'Tom Thumb'—4″ HT, dwarf mound, yellow flowers. 133, 145

Baptisia *alba*—3′ HT, white drooping flowers in late spring, pealike foliage. 113, 181

Baptisia australis—4′ HT, indigo flowers in late spring, black seed pods, gray-green pealike leaves. 9, 25, 37, 45, 61, 65, 69, 83, 107, 121, 161, 165

Baptisia bracteata—2.5′ HT, cream pendant flowers. 181

Baptisia leucantha—4′ HT, white upright flowers. 37, 181

Baptisia leucophaea—4′ HT, similar to *B. leucantha* except hairy leaves. 37, 77, 127

Baptisia minor—3′ HT, blue flowers in late spring similar to *B. australis* except smaller. 181

Bellis perennis—8″ HT, pink, white and red flowers, invasive. 133, 159

'Monstrosa'—double flowers. 83

'Pomponette Red'—fringed double red flowers. 159

'Pomponette Mix'—fringed flowers, mixed colors. 52, 107

'Pomponette Pink'—fringed double pink flowers. 159

'Pomponette White'—fringed double white flowers. 107, 159

Berlandiera lyrata—1.5′ HT, yellow daisy flower with a green center in summer, chocolate scented. 175

Biscutella laevigata—2′ HT, yellow flowers in summer, green rosettes. 161

Boltonia asteroides—4.5′ HT, white daisy flowers in fall. 49, 115

'Pink Beauty'—soft pink selection. 109

'Snow Bank'—more compact than species. 9, 27, 34, 63, 77, 109, 117, 133, 159, 165, 171, 173, 177

Buphthalum salicifolium (Inula ensifolia 'Golden Beauty')—2′ HT, deep yellow daisy flowers in summer, dark narrow green leaves. 9, 37, 49, 52, 83, 95, 133, 153, 159, 161

Bellis perennis

Calceolaria 'John Innes'—6″ HT, golden-yellow flowers spotted with red in summer. 65, 153, 171

Calla palustris—1′ HT, white and yellow flowers in spring, red berries in fall, green arrow-shaped leaves, requires wet fertile soil. 83, 120

Callirhoe digitata—2.5′ HT, white, purple and red flowers in summer, lobed hairy leaves. 139

Callirhoe involucrata—1′ HT, wine-purple flowers in summer, lobed hairy leaves. 133, 137, 173

Callirhoe triangulata—3′ HT, wine-red flowers in summer. 127, 173

Campanula alliariifolia—2.5′ HT, white bells in summer, heart-shaped leaves. 49, 52, 77, 107, 121, 159, 161

Campanula arvatica—3″ HT, deep violet-blue flowers in summer, mats of small leaves, requires excellent drainage. 145

Campanula aucheri—5″ HT, pale to violet flowers in summer, leaves downy pubescent, requires excellent drainage. 121

Campanula 'Birch Hybrid'—6″ HT, purple-blue flowers in summer, small heart-shaped leaves. 95, 133, 145

Campanula 'Blue Gown'—4″ HT, lavender-blue flowers with white center in summer. 34

Campanula carpatica (turbinata)—1′ HT, blue flowers with white center in summer. Small bright scalloped green leaves. 27, 29, 37, 39, 52, 63, 65, 77, 83, 95, 137, 153, 157, 161

'Alba'—pure white form of species. 29, 52, 63, 65, 75, 77, 83, 137, 153, 161, 177

'Blue Carpet'—6″ HT, compact growth, deep blue upright cup-shaped flowers. 9, 95

'Blue Clips'—9″ HT, blue flowers. 21, 37, 49, 52, 67, 75, 97, 107, 133, 143, 159, 169, 171, 183

'China Doll'—8″ HT, single pale blue flowers. 133, 159, 171

'Wedgwood Blue'—3″ HT, upright-facing blue flowers on compact plants. 27, 37, 171

'Wedgwood White'—3″ HT, upright-facing white flowers in summer. 95

'White Clips'—9″ HT, white flowers, compact habit. 21, 37, 49, 52, 67, 83, 97, 107, 143, 159, 161, 169, 183

'White Star'—8″ HT, large white cup-shaped flowers. 133, 171

Campanula cervicaria—2.5′ HT, biennial, blue clusters of flowers with long narrow leaves, summer bloom. 173

Campanula chamissonis (pilosa)—2″ HT, soft blue flowers in summer, matted foliage. 95, 121, 145

'Alba'—white flowers. 145

Campanula cochleariifolia (pusilla)—3″ HT, small blue bells in summer, mat trailing leaves. 49, 52, 77, 95, 97, 133, 137, 145, 159, 161, 177

alba—white flowers. 95, 145

'Miranda'—snow white. 133

'Miss Willmott'—dainty pale blue flowers. 133

Campanula collina—1′ HT, rich royal-purple flowers in summer. 95, 145, 161, 183

Campanula divaricata—1.5′ HT, small blue trailing flowers in late summer similar to *C. rotundifolia*. 66, 173

Campanula elatines—159

elatinoides—white tomentose leaves. 161

fenestrellata—3″ HT, blue stars in summer. 133, 145

garganica—3″ HT, starlike blue flowers with a white eye in summer, compact shiny rosettes. 9, 95, 133, 144, 161, 167

'Major'—4″ HT, light blue flowers with a white center.

Campanula excisa—6″ HT, dark blue flowers, funnel-shaped. 145, 161

Campanula fragilis—1.5′ HT, blue, purple flowers with white centers, somewhat tender. 133, 161

Campanula glomerata—1.5′ HT, purple flowers in summer, leaves deep green. 37, 45, 97, 122

acaulis—10″ HT, amethyst-violet flowers. 37, 61, 65, 121, 133, 145, 153, 159, 161

'Alba'—27, 29, 37, 49, 52, 159, 161, 165, 175

'Crown of Snow'—1.5′ HT, white flowers. 33, 49, 61, 133, 153, 177

'Dahurica'—1.5′ HT, dark violet. 52, 65, 83, 153, 159, 161, 175

'Joan Elliot'—1.5′ HT, deep violet flowers in early summer. 29, 37, 39, 63, 65, 77, 153, 159, 165, 169, 171, 183

'Superba'—3′ HT, large royal-purple flowers in summer. 9, 27, 29, 37, 39, 49, 61, 63, 83, 143, 159, 165, 169, 177

Campanula grossekii—3′ HT, blue flowers in summer, leaves long heart-shaped. 173

Campanula x *hallii*—3″ HT, small white bells. 133

Campanula kemulariae—6″ HT, blue flowers in summer, rhizomatous. 133, 145

Campanula lactiflora—3.5′ HT, pale lilac-blue flowers in summer. 9, 107, 159, 161, 173

'Alba'—3.5′ HT, white flowers. 161

'Loddon Anna'—4′ HT, soft pink flowers in summer, small heart-shaped leaves. 29, 34, 83, 107, 159

'Macrantha'—4′ HT, larger flowers. 52

'Rosea'—3.5′ HT, pink bells. 49, 52, 161

'White Flower Farm Select'—3′ HT, violet-blue flowers in summer, serrated pointed leaves. 177

Campanula longistyla—1.5′ HT, large blue flowers in summer, biennial. 173

Campanula makaschvilii—1.5′ HT, white bells in summer, similar to *C. alliariifolia*. 173

Campanula medium 'Calycanthema'—3′ HT, blue, rose or white flowers, resembles semidouble flower, biennial. 83, 107, 169, 175

Campanula persicifolia (latiloba and nitida)—3′ HT, blue flowers in early summer, semievergreen tufts of foliage. 3, 37, 45, 49, 61, 75, 83, 133, 139, 173, 183

'Alba'—pure white flowers. 3, 21, 37, 49, 52, 65, 83, 107, 133, 139, 145, 153, 159, 161

'Blau'—107, 169

'Blue Gardenia'—double deep silvery blue flowers. 37, 65, 95, 153

'Blue Note'—95

'Caerulea'—large single blue flowers. 37, 39, 65

'Double White'—2.5′ HT, cup and saucer shaped bells of white in early summer. 34

'Giant Hybrids'—mixed colors, large flowers. 159

'Grandiflora'—large blue bells. 52, 77, 143, 161, 165

'Grandiflora Alba'—large white bells. 77, 143, 165, 177

'Hidcote Amethyst'—lavender-pink flowers in summer. 34

'Highcliff'—violet-purple flowers. 34

'Percy Piper'—lavender-blue flowers in summer. 34

'Telham Beauty'—larger flowers. 9, 21, 159, 177

'White Knight'—white flowers. 95

'White Pearl'—double white flowers. 39, 95

Campanula portenschlagiana (muralis)—4″ HT, blue bells in summer, rhizomatous. 9, 95, 39, 161

'Resholt'—deep blue flowers in summer. 133, 177

Campanula poscharskyana—4″ HT, large violet-blue stars in summer, trailing mats of bright green foliage, rhizomatous. 9, 3729, 37, 49, 65, 95, 121, 137, 144, 153, 161, 169, 177, 183

'Stella'—deeper blue flowers, not as vigorous. 133

Campanula pulla—3″ HT, rich deep blue bells in summer. 133, 145

Campanula x *pulloides*—5″ HT, larger bells than *C. pulla* and larger leaves. 133, 145

Campanula punctata—1′ HT, creamy white flowers flushed with pink and dotted with red in summer, vigorous spreader. 143, 144, 161, 169

'Alba'—1′ HT, white flowers spotted with red in summer. 34, 133, 144

Campanula pyramidalis—6′ HT, porcelain-blue flowers in late summer, heart-shaped leaves, biennial. 49, 159, 161

Campanula raddeana—8″ HT, pendant deep violet-blue bells in summer, mat-forming dark bronze-green leaves. 95, 133

Campanula raineri—3″ HT, light blue conical bells in summer, gray-green tufts of leaves. 161

Campanula rapunculoides—3′ HT, violet flowers in summer, extremely invasive. 52, 161

Campanula rotundifolia (alaskana)—1.5′ HT, deep blue pendulous flowers in summer, short-lived perennial. 3, 37, 49, 52, 83, 97, 120, 127, 173, 177

'Alba'—white flowers. 177

'Compacta'—1′ HT, compact form of species. 133

'Olympica'—1′ HT, compact form, profuse deep blue flowers. 3, 29, 37, 65, 143, 153, 159, 169, 171, 183

'Purple Gem'—8″ HT, rich purple flowers. 95

Campanula sarmatica—1.5′ HT, pale gray, blue and white flowers in summer, leaves gray-green hairy, requires excellent drainage. 144, 159

Campanula saxifraga—4″ HT, violet-blue bells in summer, gray-green tufted foliage. 145

Campanula thyrsoides—2.5′ HT, cylindrical clusters of cream and pale yellow flowers in summer, requires excellent drainage. 161

Campanula trachelium—3′ HT, lilac and white flowers in summer, coarse leaves. 52, 161

Campanula tridentata—6″ HT, deep blue and white flowers in summer, tufted hairy rosettes of leaves. 121

Campanula x *tymonsii*—4″ HT, purple-blue flowers, miniature version of *C. carpatica*. 145

***Carlina** acaulis*—9″ HT, white daisy stemless flowers in summer, gray spiny leaves. 49

***Cassia** hebecarpa*—3′ HT, bright yellow flowers in summer, pealike leaves. 49, 127, 173

Cassia marilandica—3′ HT, bright yellow flowers in summer. 65, 69, 153, 159, 173

***Catananche** caerulea*—1.5′ HT, papery blue flowers in summer, tufts of green leaves at base, requires excellent drainage, short-lived perennial. 3, 37, 39, 61, 65, 69, 75, 97, 107, 153, 159, 161, 177, 183

'Blue Giant'—larger flowers. 171

***Centaurea** dealbata*—3′ HT, pink flowers in summer, finely divided light green leaves. 33, 49, 49, 52, 63, 65, 75, 107, 137, 159, 161, 165, 177, 183

'Rosea'—rose flowers. 52, 169

'Steenbergii'—dark carmine-lilac flowers with a white center, invasive. 39, 83

Centaurea gymnocarpa—3′ HT, leaves feltlike white woolly twice dissected, grown for its foliage, tender. 161

Centaurea hypoleuca—2′ HT, pink flowers in early summer through fall, broad lobed leaves with white undersides, seedheads resemble silvery daisies. 37, 61

Centaurea kotschyana—3′ HT, dark red flowers in summer, leaves deeply cut. 61

Centaurea macrocephala—3′ HT, yellow flowers in summer, leaves green and coarse. 33, 37, 39, 45, 49, 61, 63, 65, 75, 91, 95, 107, 153, 159, 169

'Sofia'—83

Centaurea montana—1.5′ HT, deep blue flowers with a reddish center. 21, 33, 37, 61, 65, 75, 95, 97, 107, 109, 137, 153, 159, 161, 177, 183

'Alba'—white flowers. 29

'Coerulea'—pure deep blue flowers. 52, 83, 169

Centaurea nigra 'Rivularis'—2′ HT, dark purple flowers, leaves oval and green. 61

Centaurea pulcherrima—2′ HT, clear pink flowers in early summer, leaves lobed green with white pubescence on the underside. 161

Centaurea scabiosa—5′ HT, purple flowers in summer, leaves coarse, long toothed. 153, 161

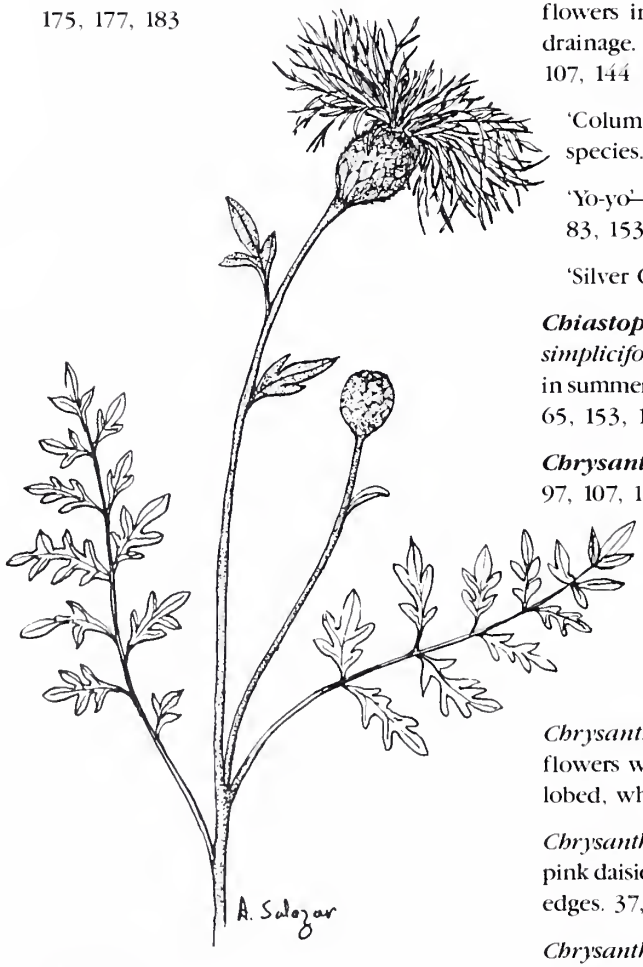
alpestris—1′ HT, mauve flowers in early summer, leaves long toothed. 83

Centaurea simplicicaulis—10″ HT, lavender-pink flowers in summer, silvery green mat forming foliage. 34

Centaurea uniflora—10″ HT, violet flowers in summer, silvery white woolly leaves. 161

Centaurium *scilloides*—3″ HT, bright pink and rose flowers, tufted green leaves. 61

Centranthus *ruber*—3′ HT, pink and white flowers in summer, succulent grayish-green leaves. 9, 37, 39, 49, 83, 91, 97, 107, 143, 165, 175, 177, 183



Centaurea scabiosa

'Albus'—white form. 37, 49, 159

'Coccineus'—deep red flowers. 29, 65, 153, 159, 169

'Roseus'—rose-red flowers. 37, 122, 159, 171

Cephalaria *alpina (Scabiosa alpina)*—95

Cephalaria gigantea—6′ HT, yellow flowers in summer, leaves coarse, dark green. 49, 52, 77, 159, 161

Cerastium *biebersteinii*—6″ HT, white flowers in early summer, leaves grayish woolly, requires excellent drainage. 65, 83, 153, 159, 161

Cerastium tomentosum—6″ HT, white flowers in early summer, requires excellent drainage. 5, 21, 33, 37, 49, 67, 76, 83, 97, 107, 144

'Columnae'—3″ HT, more compact than species. 52

'Yo-yo'—more compact than species. 3, 65, 83, 153, 159, 161, 169

'Silver Carpet'—3, 27

Chiastophyllum *oppositifolium (Cotyledon simplicifolia)*—6″ HT, small deep yellow bells in summer, succulent green leaves turning red. 65, 153, 171

Chrysanthemum collection—63, 75, 83, 95, 97, 107, 177

Chrysanthemum alpinum—6″ HT, white flowers with an orange center in fall, leaves lobed, white and woolly. 3

Chrysanthemum arcticum—1′ HT, white or pink daisies in fall, leaves shiny, with scalloped edges. 37, 49

Chrysanthemum atlanticum—10″ HT, pure white daisies in summer, fernlike silvery green

leaves, rhizomatous. 37, 145

Chrysanthemum coccineum (Pyrethrum coccineum)—2′ HT, mixed daisy flowers in summer, ferny green leaves. 9, 27, 37, 63, 77, 115, 137, 165

'Album'—white flowers. 177

'Atrosanguineum'—large single red flowers. 159

'James Kelway'—crimson flowers. 122, 165, 169, 171, 175

'Park's Prize'—double flowering mix. 183

'Robinson's Carmine'—single carmine flowers. 83

'Robinson's Pink'—single pink flowers. 161

'Robinson's Dark Crimson'—large single crimson flowers. 21, 37, 65, 107, 137, 153, 177

'Robinson's Doubles'—mixed double flowers. 159

'Robinson's Hybrids'—large single flower mix. 33, 39, 65, 75, 97, 107, 161, 169, 183

'Robinson's Rose'—large single rose flower. 21, 107

'Roseum'—vivid rose-pink flowers. 3, 49, 65, 137, 153, 169

Chrysanthemum frutescens—3′ HT, yellow flowers with white or lemon-yellow center, tender. 52

Chrysanthemum haradjanii (Tanacetum densum amanum)—6″ HT, yellow buttonlike flowers, leaves featherlike, silvery-gray, pungent when crushed, requires good drainage and sandy soil. 97, 98, 145

Chrysanthemum hosmariense—1′ HT, white flowers with a yellow center in late summer, leaves gray. 145

Chrysanthemum indicum—3′ HT, yellow flowers in late summer, leaves cleft, felty gray beneath. 181

Chrysanthemum leucanthemum—2.5′ HT, white flowers in late spring. 5, 49, 52, 66, 95, 97, 115, 117, 123, 144

'May Queen'—3′ HT, single flowers in spring, earlier than species. 3, 33, 49, 109, 159

Chrysanthemum nipponicum—3′ HT, large white daisy flowers in fall, thick dark green leaves. 9, 37, 49, 52, 91, 144, 159, 171

Chrysanthemum parthenium—2.5′ HT, small single white flowers with a yellow center in summer and fall, fragrant ferny leaves. 9, 63, 69, 75, 109

'Aureum'—yellow leaves. 65, 153, 183

'Fortuna'—single white flowers. 159

'Golden Ball'—10″ HT, double golden yellow flowers. 37, 107, 159

'Midas Touch'—yellow leaves. 98

'Old-Fashioned'—2′ HT, white flowers with a yellow center. 37

'Snowball' ('White Stars')—6″ HT, white buttonlike flowers. 37, 107, 159

'Ultra Double White'—2′ HT, double white flowers. 65, 107, 153

Chrysanthemum ptarmiciflorum—1′ HT, leaves of "silver feathers". 133

Chrysanthemum serotinum (uliginosum)—6.5″ HT, white flowers in fall, coarse toothed leaves. 34

Chrysanthemum x *superbum*—3′ HT, white flowers in summer. 139

'Aglaya'—2.5′ HT, double fringed petals. 9, 37, 52, 65, 95, 97, 137, 153, 169, 171, 183

'Alaska'—2′ HT, single flowers. 21, 29, 33, 37, 49, 52, 63, 65, 75, 97, 107, 143, 153, 157, 159, 165, 169, 171, 175, 183

'Antwerp Star'—4′ HT, large single flowers. 83, 159, 161

'Cobham Gold'—2.5′ HT, large double cream flowers with light yellow in center. 9, 37, 49, 65, 95, 153, 169, 171

'Dieners Giant Double'—2′ HT, double white flowers. 21, 33, 63, 107, 183

'Diener's Riesen'—3.5′ HT, semidouble flowers. 161

'Enzett Amelia'—65, 153, 165

'Esther Reid'—3, 139

'Flore Plena'—double flowers. 3

'Hartje Elder'—single flowers. 65, 153

'Little Miss Muffet'—1′ HT, semidouble flowers. 9, 37, 52, 63, 77, 95, 157, 175, 177

'Little Princess'—1′ HT, large single flowers. 33, 37, 133, 169

'Lucky Star'—single flowers. 63

'Lyndsey Dawn'—2′ HT, large single flowers with a green center. 37, 153

'Majestic'—153, 165

'Marconi'—double and semidouble flowers. 21, 83, 159, 165, 169, 177

'May Queen'—blooms ealier in spring. 21, 52, 63, 139

'Mount Hood'—34, 95

'Mount Shasta'—double flowers with a high center crest. 9, 37, 153

'Polaris'—4′ HT, large snowy white flowers. 3, 9, 52, 65, 83, 107, 153, 161, 177

'Roggli's Super Giant'—semidouble flowers. 52, 63

'Secundum'—single flowers. 63

'Sieger'—large pure white flowers. 52, 161

'Silver Princess'—1.5′ HT, single and semidouble flowers. 3, 21, 37, 52, 65, 83, 107, 137, 153, 159, 161

'Snowcap'—1.5′ HT, compact, blooms in midsummer. 122, 169, 171

'Snow Lady'—1′ HT, single flowers in late spring. 27, 37, 61, 65, 175

'Stamm Potschke'—large double and semidouble flowers. 137, 159, 161

'Starburst'—large single flowers, reblooms. 27, 33, 37, 65, 161, 175

'Supra'—very large flowers. 161

'T. E. Killen'—1.5′ HT, double row of petals, crested soft yellow center. 9, 34, 37, 65, 77, 95, 153, 165, 167, 169, 183

'Tinkerbell'—1′ HT, single flowers. 37, 133

'Wirral Pride'—2′ HT, shorter petals, larger center crest. 3, 9, 37, 65, 95, 153, 165, 183

Chrysanthemum weyrichii—1′ HT, pink flowers in summer, leaves lobed and fleshy, semievergreen rosettes. 9, 49, 95, 133, 144, 177

'Pink Bomb'—pink flowers in late summer. 37, 65, 107, 153, 177

'White Bomb'—white flowers in late summer. 9, 37, 49, 65, 137, 145, 153, 177

Chrysanthemum zawadskii latilobum (rubellum) 'Clara Curtis'—2.5′ HT, clear pink flowers in late summer, lobed leaves. 9, 34, 37, 52, 54, 61, 65, 83, 95, 107, 153, 159

Chrysopsis mariana (Heterotheca mariana)—2′ HT, yellow flowers in late summer, leaves silky hairy green. 109, 113, 117, 157, 159, 173

Chrysopsis villosa—4′ HT, yellow flowers with a yellow center in late summer. 37, 65, 95, 153, 165, 173

rutteri ('Golden Sunshine')—bright yellow flowers with a yellow center in late summer, densely pubescent leaves. 54, 177, 181

Cirsium japonicum 'Early Rose Beauty'—2.5′ HT, rose flowers in summer, leaves lobed spiny toothed. 161

Cirsium spinosissimum–2′ HT, pale yellow flowers in summer, leaves lobed spiny toothed. 49

Cistus laurifolius—5′ HT, white flowers with yellow blotch in summer, dark green evergreen leaves , white beneath, tender. 161

***Conradina** canescens*—2′ HT, pale purple flowers in summer, leaves rosemarylike, gray pubescent, fragrant, tender. 54, 98

Coreopsis auriculata

Conradina verticillata—2′ HT, creamy white flowers in spring, dark green needlelike pine-scented leaves. 54, 98

***Convolvulus** elegantissimus*—trailing vine with pink flowers, arrow-shaped dark green leaves, requires good drainage, tender. 34

***Convolvulus** mauritanicus*—trailing vine with lavender-blue flowers, lush green leaves, requires good drainage, tender. 34

***Coreopsis** auriculata*—1.5′ HT, bright yellow daisies in early summer, leaves semievergreen, stoloniferous. 113, 115, 117, 157, 173

'Nana'—6″ HT, orange-yellow flowers with fringed petals. 9, 37, 49, 83, 109, 133, 137

Coreopsis grandiflora—2′ HT, yellow daisies in summer. 'Baby Sun'—1.5′ HT, double or semidouble yellow flowers. 3, 21, 49, 63, 109, 115, 137, 161, 165, 175, 183

'Double New Gold'—double golden-yellow flowers. 65, 153

'Double Sunburst'—semidouble flowers. 107, 159

'Goldfink'—10″ HT, deep yellow flowers. 9, 37, 49, 65, 95, 109, 153, 159, 165, 169, 171, 177

'Schnittgold' ('Cutting Gold')—single flowers. 9, 161

'Sonnenkind' ('Sunchild')—1.5′ HT, compact plant with golden-yellow flowers. 52, 83

'Sunburst'—1.5′ HT, large golden-yellow flowers. 21, 39, 63, 75, 83, 165, 171, 183

'Sunray'—1.5′ HT, semidouble or double yellow flowers. 9, 21, 27, 33, 37, 49, 52, 65, 77, 83, 97, 122, 153, 161, 165, 169, 171, 175, 183

Coreopsis integrifolia—yellow flowers in late summer, dark green leaves. 181

Coreopsis lanceolata—2′ HT, yellow flowers in summer, lance-shaped leaves. 5, 52, 55, 113, 115, 123, 157

'Baby Gold'—16″ HT, golden-yellow flowers. 9

'Brown Eyes'—1.5′ HT, golden-yellow flowers with a dark ring near center. 133, 159, 161, 177

'Gnome'—6″ HT, golden-yellow flowers. 3

'Goldtepick'—1′ HT, golden-yellow flowers. 9

'Louis D'Or'—3′ HT, double gold flowers. 3, 161

'Mayfield Giants'—1.5′ HT, single golden yellow flowers. 39

'New Gold'—2.5′ HT, double golden flowers. 177

'Sternthaler' ('Star Valley')—similar to 'Brown Eyes'—159, 161

Coreopsis major—2.5′ HT, yellow flowers in early summer, rhizomatous. 173

stellata—2.5′ HT, yellow flowers in summer, leaves whorled. 181

Coreopsis verticillata—2′ HT, bright yellow flowers in summer, upright, bushy threadlike leaves, rhizomatous. 3, 49, 91, 113, 171, 173

'Golden Showers' ('Grandiflora')—clear yellow flowers in summer. 29, 37, 39, 52, 61, 65, 91, 97, 107, 153, 159, 165, 177

'Moonbeam'—1.5′ HT, glowing pale yellow flowers in summer, not as vigorous as species. 9, 11, 21, 27, 29, 34, 37, 49, 52, 61, 65, 77, 91, 95, 107, 117, 122, 133, 137, 153, 157 159, 165, 169, 171, 173, 175, 177

'Zagreb'—15″ HT, clear yellow flowers. 3, 9, 21, 34, 37, 65, 77, 83, 91, 107, 133, 153, 159, 165, 169, 171, 173, 177

Corynophorous *canescens*—6″ HT. 3, 144

Coryphantha *vivipara*—Ball Cacti, 6″ HT, pink to purple flowers.

alversonii—8″ HT, chartreuse flowers, white spines tipped in brown or black. 87

arizonica—2″ HT, pink flowers. 87

deserti—6″ HT, straw-yellow flowers, dense spines. 87

kaibabensis—2″ HT, similar to *arizonica*, but with comblike spine arrangement. 87

vivipara—4″ HT, pink flowers with a yellow center, brown spines, green fruits. 87

Cosmos *atrosanguineus*—2′ HT, velvety maroon , chocolate scented flowers in summer, reddish-green leaves, tender. 34

Cotula *squalida*—4″ HT, yellow flowers in summer, soft hairy branches with ferny narrow leaves, tender. 144

Crambe *cordifolia*—6′ HT, white large flowers in early summer similar to baby's breath but foul smelling, leaves coarse and large. 9, 34, 95, 159

Crambe maritima—2′ HT, white flowers similar to *C. cordifolia* in early summer, leaves lobed and glaucous. 159

Crucianella *stylosa (Phuopsis stylosa)*—1′ HT, small pink flowers on dense heads in summer, narrow whorled leaves on trailing stems, rhizomatous, invasive, smell skunklike. 49

Cynoglossum *nervosum*—2′ HT, pure intense blue flowers in early summer, leaves narrow and green. 177

Cynoglossum nervosum—2′ HT, pure intense blue

Daucus *carota*—4′ HT, white flowers in summer, dissected green leaves, biennial. 52, 113, 115, 123, 157

Delosperma *cooperi*—4″ HT, bright purple flowers all summer, leaves succulent green, requires good drainage. 54, 97, 144, 145, 173

Delosperma nubigenum—4″ HT, yellow flowers in summer, succulent green leaves turning red in fall, hardier than *D. cooperi*. 54, 97, 109, 117, 144, 145, 173

Delosperma sutherlandii—4″ HT, shiny silvery pink flowers in summer, succulent green leaves, requires excellent drainage. 144

Delphinium, all have dark green cleft foliage, bloom in early summer and require rich soil.

Delphinium 'Astolat' ('Aristocrat')—6′ HT, lavender-pink and dark blue flowers. 37, 39, 75, 83, 153, 159, 169, 177

Delphinium x *belladona (formosum)*—4′ HT, rich blue and yellow flowers. 9, 21, 83, 107, 121, 153, 169, 177

'Bellamosum'—bright deep blue flowers. 3, 9, 29, 37, 52, 83, 107, 153, 159, 169, 177

'Berghimmel'—soft blue flowers. 83

'Casa Blanca'—pure white flowers. 49, 83, 107, 153, 159, 177

'Cliveden Beauty'—sky-blue flowers. 3, 29, 37, 49, 83, 107, 159

'Finsteraarhorn'—cobalt-blue to purple flowers. 83

'Mrs. Newton Lees'—soft blue flowers. 83

Delphinium 'Blackmore and Langdon Hybrids'—6′ HT, mix of double and single flowers of vivid colors. 107, 171, 177

Delphinium 'Blue Dawn'—3′ HT, dark blue and white flowers. 159

Delphinium 'Blue Springs'—3′ HT, blue-lavender flowers. 3

Delphinium cardinale—4′ HT, red and yellow flowers. 3

Delphinium 'Cameliard'—5′ HT, soft lavender and white flowers. 3, 107

Delphinium 'Fantasia'—3′ HT, mixed colors of blue and white. 27

Delphinium 'Foerster's Hybrid'—6′ HT, mixed colors. 3

Delphinium glaucum—4′ HT, violet-purple flowers, leaves glaucous. 5

Delphinium grandiflorum (chinense)—2.5′ HT, dark blue flowers. 37, 137, 153

'Alba'—white flowers. 153

'Blue Elf'—1′ HT, blue flowers. 9, 175

'Blue Mirror'—2′ HT, deep blue flowers. 37, 177

'Blue Butterfly'—2.5′ HT, blue flowers. 3, 83, 107, 133, 159

'Butterfly Compacta'—1.5′ HT, gentian-blue flowers. 52, 159

Delphinium nudicaule—1′ HT, soft orange to red flowers. 83, 169

Delphinium 'Pacific Giant Hybrids'—6′ HT, double flowers, mixed colors. 27, 33, 67, 137

'Black Knight'—deep midnight blue. 3, 21, 37, 39, 49, 75, 83, 97, 107, 153, 159, 169, 177

'Blue Bird'—6′ HT, medium blue flowers. 9, 37, 49, 75, 83, 97, 107, 159, 169, 177

'Blue Fountains'—4′ HT, blue flowers. 9, 21, 39, 63, 83, 97, 107, 153, 171, 175

'Blue Jay'—true blue and dark blue flowers. 3, 21, 83, 107, 159

'Blue Springs'—3′ HT, blue and lavender flowers. 3, 37, 159

'Connecticut Yankee'—2′ HT, light blue, lavender and white flowers. 21, 37, 49, 52, 63, 83, 107, 109, 153, 159, 169, 177

'Galahad'—white flowers. 3, 21, 37, 39, 49, 52, 83, 97, 107, 153, 159, 169, 177

'Guinevere'—lavender and white flowers. 3, 21, 37, 39, 49, 52, 97, 107, 153, 159, 169, 177

'King Arthur'—violet-white flowers. 21, 37, 49, 52, 75, 83, 97, 107, 159, 169, 177

'Lamartine'—4′ HT, blue flowers. 83

'Lancelot'—4′ HT, lilac, lavender and white flowers. 83

'Moerheim'—4′ HT, white flowers. 83

'Pennant Mix'—2′ HT, mixed flowers of rose, blue, white. 169, 175

'Percival'—white and dark purple flowers. 52, 159

'Round Table'—mixed blue shades. 37, 75, 95, 159, 169

'Summer Skies'—sky blue and white flowers. 9, 21, 37, 49, 52, 75, 83, 97, 107, 153, 159, 169, 177

Delphinium tatsienense—2′ HT, rich deep blue, cream and purple flowers. 109

Delphinium virescens—2′ HT, snow white flowers. 127

***Dentaria** diphylla*—1′ HT, pink and white flowers in spring, evergreen divided leaves, purple beneath, rhizomatous. 139, 157, 173

Dentaria laciniata—10″ HT, white and pale purple flowers, leaves finely dissected. 173

***Desmanthus** illinoensis*—3′ HT, white pealike flowers on long stalks in summer, leaves fine pealike, burnt orange seed pods. 127, 173

***Desmodium** canadense*—5′ HT, purple pealike flowers in summer, pealike leaves. 120, 127

Dianthus: All need good drainage, have fragrant flowers which bloom in early summer and have evergreen or semievergreen leaves.

Dianthus x *allwoodii*—12″ HT, pink flowers with a darker eye, leaves narrow, gray and tufted. 5, 63

'Agatha'—8″ HT, semidouble pink flowers with a dark scarlet eye. 37, 49, 77, 144

'Aqua'—10″ HT, double flowers. 37, 49, 95, 133, 159

'Doris'—1′ HT, double light salmon-pink flowers with a darker eye. 9, 37, 49, 65, 95, 133, 153, 171, 177

'Ian'—1.5′ HT, double red flowers. 37, 49, 159, 171, 177

'Patience'—10″ HT, fringed single pink flowers with a red eye. 37, 49

'War Bonnet'—1.5′ HT, double maroon red-flowers. 9, 29, 37, 49, 95, 159

Dianthus alpinus—8″ HT, mixed flowers of pink with a darker eye. 3, 33, 37, 65, 107, 145, 153, 161, 177, 183

'Bull's Eye'—single deep crimson flowers. 167

'Cherry Beauty'—red single flowers. 133

'Little Bobby'—single raspberry-red flowers with a darker eye. 37, 137, 159

'Little Boy Blue'—single white flowers, silver blue leaves. 37, 144, 159

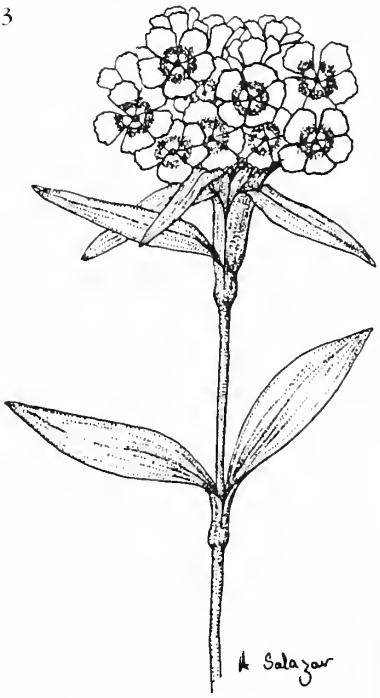
Dianthus 'Alpenflora Select'—8″ HT, mixed colors. 3

Dianthus anatolicus—1′ HT, white flowers, leaves green. 97

Dianthus arenarius—6″ HT, single white flowers, leaves green narrow tufted. 83, 152

'Snow Flurries'—8″ HT, white fringed flowers. 65, 133, 153

Dianthus x *arvernensis*–3″HT, rich pink flowers, mats of glaucous needlelike leaves. 97, 133



Dianthus barbatus

Dianthus barbatus—1′ HT, mixed shades of bright pink, red and white, dark green leaves (plum coloring in darker flowering cultivars), requires rich organic soil, biennial. 33, 37, 83, 169

'Midget' ('Pixie' and 'Double Dwarf')—8″ HT, mixed bright colors of double flowers. 65, 107, 153, 169

'Newport Pink'—1′ HT, salmon-pink flowers. 21

Dianthus 'Blush'—6″ HT, deep pink with a dark red eye. 37

Dianthus callizonus—8″ HT, large pink flowers with a blue eye, leaves grass green. 133, 145

Dianthus 'Carnation Pink'—1′ HT, bright pink flowers. 29

Dianthus carthusianorum—1.5′ HT, flowers various shades of purple, green leaves. 3, 83, 161

Dianthus caryophyllus—1.5′ HT, mixed double and semidouble flowers, glaucous leaves. 33

'Grenadin Cardinal'—1.5′ HT, double bright red flowers. 29, 97, 107, 137, 169, 183

'Golden Sun'—double yellow flowers. 21, 65, 107, 153, 159, 169

'Innocence'—1.5′ HT, double white flowers. 169

'King of Blacks'—1.5′ HT, deep burgundy flowers. 21, 65, 107, 153, 159, 169, 183

'Rose Queen'—deep rose flowers. 65, 153

'Scarlet'—10″ HT, scarlet flowers. 21, 169

'Triumph'—1.5′ HT, double clear pink flowers. 21, 159, 169

'Vienna'—semidouble and double flowers mixed. 159

'White Shades'—1.5′ HT, double pure white flowers. 21, 65, 153

Dianthus 'Charles Musgrave' ('Jealousy')—10″ HT, single white with a green eye flowers, leaves glaucous. 34, 95

Dianthus 'Cinnamon Pink'—10″ HT, pink fringed flowers, glaucous matted leaves. 98

Dianthus 'Clove Pink'—5″ HT, double pink flowers very fragrant, glaucous matted leaves. 95

Dianthus collinus—1.5′ HT, pink, purplish fringed flowers, green leaves. 161

Dianthus crinitus—8″ HT, white flowers, thin green leaves. 52

Dianthus cruentus—1.5′ HT, luminous red-purple flowers, leaves glaucous. 161

Dianthus 'Dad's Favorite'—10″ HT, white flowers with a red eye. 98, 133

Dianthus 'Danielle'—1′ HT, double rich orange to coral flowers. 95, 171

Dianthus 'Danielle Marie'—15″ HT, double salmon flowers. 9, 63, 65, 83, 133, 153, 159

Dianthus deltoides—1′ HT, mixed pink and red flowers, leaves gray-green to deep green. 3, 33, 49, 75, 177

'Albus'—8″ HT, white flowers. 107, 159, 177

'Brilliant'—8″ HT, large deep pink to red flowers. 3, 9, 21, 37, 65, 153, 161, 169

'Broughty Blaze'—8″ HT, red flowers. 144

'Erectus'—6″ HT, red flowers. 3, 161

'Fanal'—8″ HT, cardinal-red flowers. 37, 83, 159

'Fireglow'—6″ HT, flaming scarlet flowers. 161

'Flashing Light'—6″ HT, deep ruby-red flowers. 49, 83, 107, 121

'Maiden Pink'—8″ HT, clear pink flowers. 159

'Microchips'—10″ HT, scarlet to deep red flowers. 144, 175

'Roseus'—8″ HT, bright rose flowers. 3, 161

'Samos'—9″ HT, rich crimson flowers, deep green leaves. 177

'Vampire'—8″ HT, carmine flowers. 3, 49, 144, 161

'Zing'—8″ HT, large deep red flowers. 133

'Zing Rose'—6″ HT, bright rose-pink flowers. 27, 33, 49, 65, 97, 122, 153, 169, 171, 183

Dianthus 'Diana Weller'—6″ HT, lavender-pink flowers. 37

Dianthus 'Dottie'—4″ HT, white flowers with a maroon eye. 37

Dianthus 'Dubonnet'—15″ HT, large double deep wine flowers. 95

Dianthus erinaceus—3″ HT, fringed rose-red flowers, leaves prickly and tufted, requires excellent drainage. 145

Dianthus 'Essex Witch'—8″ HT, semidouble rose-pink flowers, gray leaves. 3, 9, 34, 37, 95, 133, 153, 159, 171, 183

Dianthus 'Evangeline'—15″ HT, double soft rose-pink flowers. 37, 159

Dianthus 'Fair Folley'—1′ HT, large fringed white laced flowers with a raspberry eye. 34

Dianthus freynii—4″ HT, pink flowers, densely tufted glaucous leaves, requires excellent drainage, good for scree or trough. 133

Dianthus 'Garnet Star'—10″ HT, single white flowers with a red eye, glaucous leaves. 37

Dianthus glacialis—4″ HT, pure pink flowers, densely tufted bright green leaves, requires excellent drainage, good for scree or trough. 121

gelidus—very similar to species. 133

Dianthus gratianopolitanus (caesius)—leaves glaucous and evergreen. 9, 49, 83, 137, 144, 159, 167, 177

'Cattleya'—6″ HT, pink flowers. 144

'Frikarti Alba'—6″ HT, white flowers. 144

'Grandiflorus'—8″ HT, rose-pink fringed flowers. 3, 52

'Karlik's'—6″ HT, fringed rich pink flowers. 133, 145

'Petite'—3″ HT, bright pink flowers. 9, 37, 49, 65, 153

'Pink Feather'—8″ HT, large clear pink flowers. 161

'Pink Jewel'—6″ HT, pink to red flowers. 144

'Red Eye'—6″ HT, red flowers with deeper red eye. 3

'Rose Dawn'—5″ HT, single pink flowers with a light eye. 37, 137

'Roter Kaiser' ('Rose Supreme')—6″ HT, rosy-red flowers. 3, 144

'Royal Midget'—4″ HT, large deep rose-pink flowers. 3, 37, 95, 133, 137

'Splendens'—6″ HT, red flowers. 3, 159, 161

'Tiny Rubies'—2″ HT, brilliant double pink flowers, deep green leaves. 5, 9, 27, 29, 37, 63, 65, 77, 83, 95, 133, 137, 145, 153, 159, 167, 169, 177, 183

Dianthus haematocalyx pindicola—8″ HT, red purple and gold flowers, leaves green and tufted. 137

Dianthus 'Helen'—10″ HT, deep salmon-pink flowers. 9, 27, 29, 37, 65, 77, 95, 122, 137, 153, 159, 171

Dianthus 'Her Majesty'—10″ HT, double white flowers, glaucous tufted leaves. 37, 65, 153, 159

Dianthus 'Highland Hybrids'—15″ HT, mixed flower colors with a crimson eye. 175

Dianthus 'Horatio'—8″ HT, large pink flowers with a red eye. 37, 95

Dianthus 'Ipswich Crimson'—10″ HT, clove-pink flowers. 159

Dianthus 'Inchmery'—10″ HT, double china pink flowers. 34

Dianthus knappii—15″ HT, pale yellow

flowers with a brown center, leaves hairy and green. 3, 33, 49, 65, 117, 122, 153, 159, 161, 171, 175, 183

Dianthus 'Labourbille'—3″ HT, fringed pink flowers, silver leaves in tufts, requires excellent drainage. 9, 37, 77, 133, 137, 145

Dianthus 'Labourbille Alba'—3″ HT, fringed white flowers. 137, 145

Dianthus 'Lace Pink'—1′ HT, fringed rose-pink flowers. 37, 183

Dianthus x *latifolius*—10-16″ HT, single to double flowers of rose to dark red.

'Beatrix'—10″ HT, double salmon-pink flowers, dark green leaves. 37, 98, 159

'Emile Pare'—10″ HT, semidouble to double pink flowers. 37

'Furst Bismark'—10″ HT, double rose-red flowers. 37, 159

Dianthus 'Little Jock'—6″ HT, white and pink flowers, leaves glaucous, mat-forming. 144

Dianthus 'Margaret Curtis'—7″ HT, pure white flowers with a burgundy eye, leaves glaucous. 77

Dianthus 'Mars'—6″ HT, double crimson flowers. 145

Dianthus 'May Blossom'—1.5′ HT, double pink flowers. 159

Dianthus microlepis—4″ HT, pink flowers nearly stemless, leaves densely tufted. 133

'Albus'—white flowers. 133

Dianthus 'Mrs. Holt'—6″ HT, small light pink flowers, leaves curled and glaucous. 133

Dianthus monspessulanus—12″ HT, large carmine-pink flowers, tufted green leaves. 48, 52, 161

Dianthus myrtinervius—2″ HT, pink flowers, tufted green leaves. 65, 153

Dianthus nardiformis—4″ HT, fringed plum flowers, green densely tufted leaves. 133

Dianthus nitidus—10″ HT, bright pink flowers, leaves bright green mat-forming. 109, 133, 161

Dianthus 'Oakington Hybrid'—4″ HT, double soft pink flowers. 37

Dianthus 'Old Spice'—1′ HT, double salmon-pink fringed flowers. 37, 159

Dianthus 'Oppenheimer's Red'—1′ HT, red flowers with a dark purple eye. 153

Dianthus 'Painted Beauty'—8″ HT, crimson and white flowers. 37, 133

Dianthus 'Painted Lady'—10″ HT, light pink flowers with irregular splashes of deep red. 34

Dianthus pavonius (neglectus)—4″ HT, cherry-rose flowers in summer, leaves tufted and green, requires good drainage. 3, 145, 151, 169

Dianthus petraeus—6″ HT, white or pink fringed flowers, leaves tufted. 3, 161

'Alba'—6″ HT, white flowers. 77

noeanus—2″ HT, white fringed flowers, mat-forming spiky green leaves. 133, 145

'Squarrosa'—6″ HT, white flowers. 137

Dianthus 'Pikes Pink'—4″ HT, double pink flowers. 34

Dianthus 'Pink Princess'—1′ HT, double pink flowers. 63, 95, 183

Dianthus plumarius—15″ HT, purplish fringed white and rose flowers, leaves narrow and gray. 3, 33, 37, 67, 75, 109, 167

albiflorus—1′ HT, semi-double and double white flowers. 3, 161

'Aqua'—1′ HT, double white flowers. 29, 65, 137, 171, 183

'Ballade'—1′ HT, double flowers of mixed colors. 3, 109, 161

'Boutonniere'—8″ HT, white flowers. 21, 37, 91

'Innocent'—1.5′ HT, feathery white flowers. 161

'Menus Nanus'—1.5′ HT, rose flowers. 83

praecox—1′ HT, white flowers, earlier than species. 183

'Roseus'—1.5′ HT, semidouble to double rose-pink flowers. 3, 161

'Sonata'—1′ HT, fringed petals with raspberry stripes. 37

'Spring Beauty Mix' ('Joy of Spring' and 'Spring Magic') - 1.5′ HT, large double pink, rose, salmon and white flowers. 3, 21, 83, 107, 159, 161, 169, 171, 175, 183

Dianthus pontederae—4″ HT, red flowers, leaves green and linear. 161

Dianthus 'Pretty Dottie'—8″ HT, white flowers with deep maroon spots on petals, compact plant. 98

Dianthus 'Raspberry Delight'—5″ HT, shocking pink flowers. 133

Dianthus 'Raspberry Tart'—10″ HT, double raspberry-pink flowers with maroon center ring. 9, 37, 95, 137, 153

Dianthus 'Robin'—1′ HT, double pale salmon to orange flowers. 159

Dianthus 'Rose du Mai'—10″ HT, double lilac-pink. 34

Dianthus 'Scarlet Pimpernel'—37

Dianthus seguieri—1′ HT, pinkish-red flowers, leaves tufted and green. 161

Dianthus 'Snowbank'—1′ HT, frilled double white flowers. 159

Dianthus 'Snowfire'—8″ HT, rose flowers. 144

Dianthus 'Snow Flurries'—8″ HT, fringed white flowers. 137

Dianthus 'Spotlight'—15″ HT, rich double crimson flowers. 37, 159

Dianthus 'Spotty'—8″ HT, rose-red flowers edged with silver. 9, 37, 65, 83, 95, 133, 144, 145, 153, 159, 167

Dianthus squarrosus 'Nanus'—4″ HT, white flowers, leaves linear, tufted, uptuned at end. 133

Dianthus 'Strawberry Ice Cream'—10″ HT, pink flowers with a dark pink eye. 37

Dianthus subacaulis (brachyanthus)—6″ HT, pink flowers, leaves mat-forming. 133

Dianthus superbus—2′ HT, fringed lilac or pale rose petals deeply cut, leaves gray-green, linear and tufted. 3, 161

'Longicalycinus'—2′ HT, pink flowers with an elongated calyx. 173

Dianthus 'Susan's Favorite'—8″ HT, white flowers with a red eye. 95

Dianthus 'Swarthmore'—8″ HT, fringed white flowers with a raspberry center and edging. 37

Dianthus 'Sweet Memory'—1′ HT, semidouble white flowers with a pink eye. 9, 37, 65, 153, 159

Dianthus sylvestris—1′ HT, pink flowers, leaves densely tufted, green and narrow, tolerates partial shade. 52, 161

frigidus-5″ HT, pink flowers. 121

Dianthus 'Telstar'—5″ HT, white, pink and red flowers, leaves gray-green. 157

Dianthus 'Wallace Red'—5″ HT, double dark red flowers. 37, 83, 153, 159

Dianthus 'White Hills'—4″ HT, white and pink notched flowers. 144

Dictamnus albus (fraxinella)—3′ HT, white flowers with long stamens in early summer, leaves dark green divided with citrus odor. 9, 29, 37, 63, 83, 107, 153, 159, 183

'Purpureus' ('Rubra')—3′ HT, soft mauve to purple flowers with darker veining. 9, 29, 83, 107, 153, 183

Doronicum cordatum (caucasicum and columnae)—1.5′ HT, bright yellow daisies in spring, leaves heart-shaped with scalloped edges, can tolerate partial shade, goes dormant in summer. 3, 21, 33, 37, 75, 83, 121, 183

'Finesse'—1.5′ HT, bright yellow flowers larger than species. 9, 37, 95, 97, 153, 159, 161

'Magnificum'—2′ HT, larger yellow daisies. 3, 27, 37, 65, 83, 107, 137, 143, 153, 159, 169, 161, 171, 175, 177

Doronicum 'Madame Mason'—2.5′ HT, large yellow daisies in spring. 9, 83, 95

Dorycnium hirsutum—2′ HT, white flushed pink pealike flowers in summer, soft silver hairy leaves. 34

Draba: All require excellent drainage and bloom in the spring.

Draba aizoides—4″ HT, yellowish flowers, tufted rosettes of leaves. 83

Draba bruniifolia olympica—3″ HT, yellow flowers, leaves mossy green and tufted. 145

Draba dedeana—3″ HT, white flowers, leaves small wide bristle tipped. 11, 145

Draba kotschyi—4″ HT, white flowers, leaves oblong in tight rosettes. 121

Draba lasiocarpa—8″ HT, deep yellow flowers, leaves linear in tight rosettes. 159

Draba oligosperma—2″ HT, yellow flowers, leaves hairy green rosettes. 145

Draba polytricha—2″ HT, stemless yellow flowers, leaves woolly, silver rosettes, needs protection from winter moisture. 145

Draba rigida—3″ HT, yellow flowers, leaves in dense hairy tufts. 133

Draba x *salomonii*—4″ HT, large white flowers, leaves hairy green rosettes. 145

Draba sibirica (repens)—2″ HT, yellow flowers, leaves oblong lance-shaped on trailing stems. 37, 65, 83, 137, 153

Dracocephalum prattii—3′ HT, blue-violet spikes, rounded green leaves, will tolerate partial shade, requires moist soil. 52, 161

Dracocephalum rupestre (Nepeta grandiflorum)—2′ HT, violet-blue spikes in summer, small oval gray-green aromatic leaves. 69

Dracocephalum ruyschiana—2′ HT, violet-blue flowers, leaves linear to lance-shaped. 121

Dryas drummondii—3″ HT, creamy yellow nodding flowers in late spring, leaves evergreen with white woolly undersides, will tolerate partial shade, requires excellent drainage. 95

Dryas octopetala—5″ HT, white flowers with yellow centers in late spring, leaves evergreen toothed with white woolly undersides, silky seed heads, requires excellent drainage. 3, 95, 133, 145, 159

'Minor'—2″ HT, dwarf form. 95, 145

Duchesnea indica—2″ HT, yellow flowers in spring, leaves strawberrylike, small red strawberrylike fruits, stoloniferous. 83, 97, 121, 159

Echinacea: All prefer moisture retentive soils.

Echinacea angustifolia—2′ HT, purple to rose to white flowers in summer, drooping petals, leaves dark green. 173

Echinacea pallida—3′ HT, purple to white flowers in summer, pale pink drooping petals, leaves narrow, slightly gray. 49, 107, 117, 123, 127, 157, 173

Echinacea purpurea (Rudbeckia purpurea)—4′ HT, rose-purple flowers. 5, 21, 25, 37, 45, 52, 65, 69, 75, 77, 83, 91, 97, 107, 109, 113, 115, 117, 123, 127, 133, 137, 153, 157, 165, 173, 181, 183

'Alba'—white flowering form. 37, 65, 122, 137, 165, 169, 173

'Bright Star' ('Leuchstern')—2.5′ HT, rose-red flowers with a maroon center. 9, 27, 29, 37, 39, 49, 63, 65, 83, 95, 107, 122, 144, 153, 159, 161, 165, 169, 171, 173, 175

'Magnus'—3.5′ HT, rose-red flowers, petals held horizontally. 37, 49, 65, 153, 159, 165, 169

'Ovation'—3.5′ HT, rose-pink flowers held horizontally. 175

'White Lustre'—2.5′ HT, ivory-white flowers. 9, 27, 29, 107, 159

'White Swan'—3′ HT, white flowers. 33, 175

Echinocereus *engelmannii*—2′ HT, purple to lavender flowers in spring, red fruits.

chysocentrus—1′ HT, purple flowers, reddish spines. 87

variegatus—1′ HT, purple flowers, spines white, black and brown. 87

Echinocereus 'Oklahoma'—yellow to orange flowers in spring. 144

Echinocereus reichenbachii—6″ HT, purple and pink flowers, dark spines. 87

albispinus—red, yellow and brown spines. 87

reichenbachii (caespitosus)—straw-colored to gray spines. 87

Echinocereus triglochidiatus— 1′ HT, scarlet or crimson flowers in spring, white woolly spines, red oblong fruit.

melanacanthus—8″ HT, red flowers. 87

mojavensis—10″ HT, orange to red flowers, long twisting spines. 87

Echinocereus viridiflorus—6″ HT, chartreuse flowers, purple needlelike spines. 87

Echinops *ritro (humilis and exaltatus)*—5′ HT, blue flowers in late summer, glossy green leaves above, prickly and white woolly beneath. 21, 33, 39, 49, 52, 63, 65, 69, 75, 83, 107, 109, 165, 169, 177

'Blue Globe'—3.5′ HT, deep blue flowers. 37, 165

'Taplow Blue'—4′ HT, steel-blue flowers. 9, 37, 95, 122, 144, 153, 159, 171

'Veitch's Blue'—4′ HT, more flowers but smaller, leaves grayer. 37, 153, 159

Edraianthus *graminifolius*—4″ HT, violet-blue upright bells in early summer, leaves thin green and grasslike, requires excellent drainage. 145

Edraianthus pumilio—3″ HT, bright violet flowers in early summer, leaves silver and grasslike, requires excellent drainage. 145

Epilobium *angustifolium*—5′ HT, pink flowers in late summer, narrow dark green leaves, rhizomatous, invasive. 97, 120, 127

Epilobium dodonaei—2.5′ HT, mauve-pink flowers in summer, leaves narrow grayish-green. 52

Epilobium obcordatum—6″ HT, rose to purple solitary flowers, small green leaves, sprawling habit, good scree plant.

'Strawberry'—3″ HT, glowing rosy-pink flowers. 145

Erigeron *aurantiacus*—9″ HT, bright orange flowers in summer, require well drained soil. 3, 61, 161

Erigeron aureus—6″ HT, yellow daisylike flowers in summer, requires well-drained soil. 3

Erigeron 'Blue Boy'—1.5′ HT, lilac-blue flowers. 3

Erigeron compositus—4-6″ HT, white flowers in early summer, leaves densely woolly and finely cut. 97

Erigeron 'Moerheim'—lavender flowers in summer, tender. 34

Erigeron pulchellus—2′ HT, lavender flowers, green-toothed leaves, rhizomatous, short-lived perennial. 144

Erigeron 'Red Sea'—1.5′ HT, dark violet flowers. 29

Erigeron simplex 'Eco Mt. Evans'—8″ HT, lavender flowers in early summer, straplike silver leaves. 54

Erigeron speciosus—2′ HT, violet-blue flowers in summer. 75, 97

'Azure Fairy'—2.5′ HT, semidouble lavender flowers. 3, 169, 183

'Blue Beauty'—intense double blue flowers. 161

'Dark Lilac'—2.5′ HT, dark lilac flowers. 75

'Darkest of All'—violet-blue flowers. 83

'Double Beauty'—violet-blue flowers with yellow centers. 37, 65, 153, 159, 165

'Foster's Darling'—2′ HT, bright pink flowers with yellow centers. 37, 39, 65, 83, 153, 159

'Grandiflorus'—2.5′ HT, large blue flowers. 3, 161

'Pink Jewel'—lavender-pink flowers with yellow centers. 29, 33, 37, 49, 61, 75, 83, 137, 161, 183

'Prosperity'—18″ HT, mauve-blue flowers in summer. 37, 65, 83, 153, 159, 165

'Rose Jewel'—3, 159

'Rose Triumph'—light pink flowers. 29

'Strahlenmeer'—2′ HT, soft blue flowers. 83

Erigeron thunbergii—15″ HT, blue-purple flowers, leaves tufted, pubescent. 3

***Eriogonum** umbellatum*—1′ HT, sulphur-yellow flowers in summer, leaves gray-green, woolly beneath. 5, 52, 97, 144, 159

***Eriophyllum** lanatum*—2′ HT, yellow daisies, gray dissected leaves, dislikes humidity, requires excellent drainage. 52, 65, 153, 159, 161, 165

***Erodium** x bedderi*—8″ HT, white flushed pink flowers with pink veining and a basal purple blotch, blooms in summer, requires excellent drainage, olive-green lobed leaves. 145

Erodium chamaedryoides (reichardii)—3″ HT, white flowers with rose veins in summer, leaves heart-shaped and crinkled, requires excellent drainage. 3, 49, 65, 133, 153

'Album'—2″ HT, pure white flowers. 98, 137, 145

'Plenum'—double pink flowers. 34, 95

'Roseum'—2″ HT, large deep pink flowers. 9, 34, 83, 95, 98, 121, 145

Erodium cheilanthifolium—8″ HT, white flowers with cerise veining and purple-black blotch in summer, leaves gray with silvery patches, requires excellent drainage. 145

Erodium chrysanthum—6″ HT, sulphur-yellow flowers in summer, silver filigree tufts of leaves, requires excellent drainage. 34, 95, 145

Erodium 'David Crocker'—8″ HT, white flowers with a raspberry-pink blotch in summer, silvery leaves, requires excellent drainage. 145

Erodium macradenum 'Roseum'—8″ HT, deep pink flowers with a purple blotch in summer, leaves fresh green and lacy, requires excellent drainage. 145

Erodium manescavii—1.5′ HT, pink to purple flowers in summer, green finely divided leaves, requires excellent drainage. 49, 52

***Eryngium** agavifolium*—5′ HT, thimblelike green flowers in late summer, swordlike rich green sharply toothed leaves, evergreen. 91, 159, 161

Eryngium alpinum—2′ HT, silvery blue prickly flowers in summer, blue-green rounded leaves. will tolerate light shade. 39, 83

'Blue Star'—2.5′ HT. 9, 153, 165

'Opal'—2.5′ HT. 159

'Superbum'—2′ HT, heads larger. 49

Eryngium amethystinum—2′ HT, smaller blue flowers in summer, rounded blue-green leaves. 29, 37, 65, 95, 117, 153, 159

Eryngium bourgatii—1.5′ HT, blue-green thistlelike flowers in summer with long spiny bracts, gray-green leaves with white veins. 52, 159

Eryngium giganteum—3-4′ HT, silvery blue thistlelike flowers in summer, biennial. 52, 69, 159

Eryngium planum—3′ HT, small blue flowers, blue-green round leaves. 37, 52, 61, 69, 75, 77, 95, 161, 165, 177

'Blue Dwarf'—1.5′ HT. 83, 159

Eryngium yuccifolium—3.5′ HT, small white and green flowers with small bracts, long, blue-green spiny leaves. 52, 77, 107, 117, 127, 173

Erysimum 'Bowles Mauve'—2.5′ HT, mauve fragrant flowers in late spring, blue-green leaves. 34

Erysimum 'Harper Crew'—2′ HT, double yellow fragrant flowers in late spring. 34

Erysimum helveticum—10″ HT, sulphur-yellow flowers in summer, tufted gray-green narrow leaves, requires excellent drainage. 161

Erysimum hieraciifolium—2′ HT, orange-yellow fragrant flowers in late spring, gray-green leaves, biennial. 3, 33, 55, 123, 159, 175

'Golden Bedder'—2′ HT, bright yellow fragrant flowers. 159

Erysimum 'Jubilee Gold'—6″ HT, golden-yellow fragrant flowers. 34

Erysimum kotschyanum—3″ HT, yellow flowers in late spring, tufted awllike leaves. 5, 54, 133, 145

Erysimum linifolium (Cheiranthus linifolius) 'Variegata'—6-12″ HT, apricot, mauve and purple fragrant flowers in late spring, narrow gray-green leaves edged with creamy yellow, good for rock walls, biennial. 34

Erysimum 'Orange Flame'—2′ HT, soft orange flowers. 37, 133

Erysimum pulchellum—8″ HT, yellow flowers in late spring, tufted green toothed leaves. 83

Erysimum 'Sprite'—2′ HT, yellow leaves in late spring, gray-green leaves. 133

Eupatorium *altissimum*—8′ HT, large panicles of white flowers in late summer, oblong leaves. 117

Eupatorium cannabinum—4′ HT, reddish-mauve to white flowers in late summer. 52, 69

Eupatorium coelestinum—3′ HT, violet-blue flowers in fall, green toothed leaves, rhizomatous, invasive, will grow in partial shade. 9, 34, 37, 49, 65, 77, 107, 113, 115, 117, 153, 157, 165, 173, 181

'Album'—white flowers. 37, 49, 54, 65

'Cori'—2′ HT, compact form. 9

'Wayside Variety'—1′ HT, pale lavender flowers, more compact. 37, 65, 95

Eupatorium x 'Gateway'—5′ HT, late pink flowers clusters. 91

Eupatorium hyssopifolium—4′ HT, white flat-topped clusters in late summer, narrow whorled leaves, requires average to dry soil. 117

Eupatorium maculatum—6′ HT, pale purple flat topped cluster, leaves dark green whorled, requires moist to wet soils. 25, 52, 113, 117, 127

Eupatorium perfoliatum—6′ HT, flat clusters of grayish white heads, hairy narrow leaves. 25, 52, 69, 117, 120, 173

Eupatorium purpureum—4-6′ HT, purplish-pink flowers in late summer, leaves dark green toothed and whorled, requires moist to wet soils. 9, 21, 52, 66, 69, 120, 165, 173

'Atropurpureum'—purple leaves. 165

Eupatorium rugosum (urticaefolium)—3′ HT, white clustered flowers in summer, leaves sharply toothed. 52, 54, 66

Euphorbia *characias*—4′ HT, cylindrical heads of gray-green with a dark brown center, blooms in spring, short narrow and spiral leaves, tender. 161

Euphorbia corollata—2′ HT, white bracts in summer, thin jade-green leaves. 54, 65, 66, 107, 127, 153

Euphorbia epithymoides (E. polychroma)—18″ HT, chartreuse flowers in the spring, dark green leaves turning red in fall, moundlike plant. 3, 9, 21, 37, 49, 63, 65, 69, 77, 83, 95, 97, 107, 133, 145, 153, 159, 161, 171, 173, 177

Euphorbia griffithii 'Fireglow'—3′ HT, reddish-orange flowers in early summer, leaves green, turning red in the fall. 9, 27, 34, 37, 83, 153, 159, 171

Euphorbia lathyris—3′ HT, yellow flowers, pointed gray-green leaves, biennial. 37

Euphorbia 'Martinii'—2′ HT, yellowish flowers with a dark eye, stems densely set with a gray-green tinted bronze coloring, tender. 34

Euphorbia myrsinites—18″ HT, chartreuse flowers in spring, blue-green pointed foliage, trailing stems, evergreen. 9, 21, 37, 65, 95, 97, 107, 121, 153

Euryops *evansii*—2′ HT, yellow flowers, leathery dissected silver leaves, tender. 98

Euryops pectinatus—3′ HT, bright gold flowers, silver lacy leaves, tender. 98

Filipendula: All require damp to wet soils

Filipendula multijuga 'Nana'—8″ HT, pink clusters of flowers, heart-shaped lobed leaves. 54

Filipendula palmata—blooms in summer, dark green lobed leaves.

'Elegans'—4′ HT, soft salmon-pink flowers. 95, 153, 177

'Nana' (*digitata*)—1.5′ HT, pink flowers. 9, 29, 107, 159, 165, 171

'Pink Hybrid'—2′ HT, pink clusters. 34

Filipendula purpurea—4′ HT, cerise flowers in summer, dark green lobed leaves. 107

'Alba'—white flowers. 83

'Elegans'—flat clusters of pink flowers in summer. 9, 37

Filipendula rubra—6′ HT, pinkish flowers slightly fragrant in summer, dark green lobed leaves. 49, 109, 127

'Alba'—4′ HT, white flowers. 37

'Venusta' ('Magnifica')—fragrant rich pink-rose flowers. 9, 29, 37, 39, 83, 95, 107, 143, 159, 165, 171, 177

'Venusta Alba'—white fragrant flowers. 9, 29, 65, 143, 153

Filipendula ulmaria—4′ HT, white flowers in summer, dark green lobed leaves. 49, 52, 173

'Aurea'—3′ HT, white flowers, vivid golden-green leaves in spring changing to creamy yellow. 34, 49

'Flora Plena'—3′ HT, double white flowers. 9, 29, 37, 95, 159, 165, 177

'Variegata'—leaves striped with yellow. 65

Filipendula vulgaris (hexapetala)—2′ HT, white clusters of flowers in summer, finely cut dark green leaves, will not grow in damp soil. 3, 29, 37, 45, 49, 52, 61, 65, 91, 95, 143, 153, 165, 169, 173

'Aurea-Variegata'—144

'Flore Pleno'—2′ HT, double white flowers. 9, 21, 29, 39, 83, 95, 107, 143, 144, 153, 159, 171

Gaillardia *aristata*—2′ HT, brilliant yellow flowers with a red center in summer, leaves soft green and aromatic, short-lived perennial unless in sharply draining soils. 5, 75

Gaillardia x *grandiflora*—2′ HT, blooms in summer, requires well-drained soil.

'Aurea Pura'—159

'Baby Cole'—1′ HT, brilliant yellow flowers with maroon center. 37, 65, 77, 83, 122, 153, 169, 171

'Bremen'—2.5′ HT, dark scarlet flowers with yellow margins. 49, 52, 159, 161

'Burgundy'—2.5′ HT, wine-red flowers. 33, 37, 39, 49, 77, 83, 97, 107, 161, 169, 175, 177, 183

'Dazzler'—2′ HT, golden-yellow flowers with a maroon center. 3, 27, 37, 52, 107, 159, 169

'Goblin' ('Kobold')—1′ HT, red flowers with yellow margins. 3, 9, 21, 27, 37, 49, 52, 63, 67, 75, 83, 97, 107, 115, 137, 159, 161, 165, 169, 175, 177, 183

'Golden Goblin'—1′ HT, red flowers with golden-yellow margins. 37

'Maxima Aurea'—2.5′ HT, pure clear yellow flowers. 49, 52, 161

'Monarch'—2.5′ HT, mixed colors of burgundy, orange, red and yellow. 21, 107, 177, 183

'The Sun'—1.5′ HT, golden-yellow flowers. 169

'Tokajer'—2.5′ HT, orange flowers. 52

'Torch Light' ('Fackelschein')—2.5′ HT, dark flame-red flowers with yellow margins. 52, 161

'Yellow Queen'—2.5′ HT, pure golden-yellow flowers. 177

Gaillardia pulchella—1.5′ HT, yellow and red flowers in summer, requires well-drained soil. 113, 123, 157

Galega bicolor—5′ HT, deep blue and bluish-white flowers in summer, pealike leaves. 175

Gaura lindheimeri—4′ HT, white tinged with pink flowers in summer to fall, leaves sometimes tinged red. 9, 27, 34, 37, 49, 61, 65, 77, 83, 153, 159, 169, 171

Gentiana: require humus-rich well drained soil.

Gentiana acaulis—4″ HT, dark blue flowers in late spring, green mats of rosettes. 3

'Excelsa'—blue trumpet flowers. 133

Gentiana angustifolia—3″ HT, sky-blue trumpet flowers in late spring, narrow green mats of rosettes. 145

Gentiana bisetaea—18″HT, light blue flowers in summer, green lance-shaped leaves, requires moist to wet soils. 145

Gentiana cachemirica—4″ HT, tubular bright blue flowers in late summer, protrate trailing rosettes of leaves. 3, 52, 173

Gentiana calycosa—8″ HT, dark blue flowers spotted with green in fall, trailing stems with oval leaves, moist to wet soils. 145

Gentiana clusii—4″ HT, solitary funnel-shaped dark blue flowers. 95, 145

Gentiana cruciata—8″ HT, blue clusters of flowers in early summer, broad rosettes of leaves on trailing stems. 3, 52, 173

Gentiana lagodechiana—6″ HT, similar to *G. septemfida*, but flowers earlier. 83, 145, 159, 161, 177

Gentiana lutea—5′ HT, bright yellow-gold flowers in summer, leaves long and oval. 161

Gentiana newberryi—4″ HT, deep blue flowers in late summer, darkly speckled, leaves green and round. 145

Gentiana olivieri—9″ HT, deep blue bell-shaped flowers in summer, rosettes of leaves. 143

Gentiana saponaria—1.5′ HT, bright blue flowers in fall opening partially, narrow green leaves, tolerates drier soil. 173

Gentiana septemfida—6″ HT, dark blue flowers in late summer, trailing stems. 65, 143, 145

Gentiana straminea—1′ HT, pale yellow or greenish-white bell-shaped flowers in early summer, lance-shaped leaves. 161

Geranium: prefer moist humus-rich well-drained soil, require sun or partial shade and have lobed leaves, many rebloom in fall and have reddish fall color.

Geranium balkanum—1.5′ HT, royal-purple flowers in early summer, velvety green pungent smelling leaves. 98

Geranium cinereum—6″ HT, pink flowers with dark stripes in early summer and fall, deeply toothed lobed leaves. 'Ballerina'—4″ HT, large lilac-pink flowers with darker veins in the center. 9, 29, 34, 37, 65, 83, 95, 133, 139, 153, 171, 177

'Lawrence Flatman'—6″ HT, similar to 'Ballerina' but each petal has a dark blotch of crimson-purple. 34

subcaulescens—6″ HT, crimson-magenta flowers with a dark eye. 34, 139

'Splendens'—6″ HT, vivid crimson-purple flowers with a black center, gray-green leaves. 9, 83, 133, 177

Geranium 'Claridge Druce'—2′ HT, bright magenta-pink flowers in early summer, divided gray-green leaves, vigorous but sprawling and will climb into shrubs. 37, 49, 77, 122, 165, 171

Geranium dalmaticum—6″ HT, delicate pink-veined crimson flowers in early summer, leaves small, mat-forming, brilliant crimson in fall. 3, 29, 34, 37, 45, 49, 65, 83, 95, 133, 137, 139, 145, 153, 159, 177, 183

'Album'—6″ HT, white flowers with slightly pink blush in center. 77, 95, 145

Geranium endressii—1.5′ HT, bright chalky-pink flowers in early summer and fall, divided light green leaves , semievergreen. 5, 29, 91, 137, 173

'A. T. Johnson'—10″ HT, silvery pink flowers, finely cut green leaves. 34, 95

'Rose Claire'—10″ HT, similar to 'A.T. Johnson' but flowers are clear rose-salmon. 95

'Wargrave Pink'—bright salmon-pink flowers. 9, 21, 27, 29, 37, 39, 49, 63, 65, 83, 91, 97, 107, 133, 137, 139, 143, 153, 159, 165, 169, 171

Geranium eriostemon reinii—2′ HT, violet-blue flowers in early summer, large dark green leaves with paler green center blotches. 173

Geranium himalayense (grandiflorum)—1′ HT, intense blue-violet flowers, brilliant red fall color. 9, 45, 95, 133, 137, 139, 143, 145, 159, 169, 171

'Flore Pleno' ('Birch Double')—double lilac-purple flowers, finely cut leaves, good red fall color. 9, 37, 54, 65, 133, 143, 159, 169, 171

'Johnson's Blue'—1.5′ HT, violet-blue flowers, finely divided leaves, good red fall color. 3, 9, 21, 29, 37, 39, 77, 83, 91, 107, 122, 133, 137, 139, 143, 144, 153, 165, 169, 171

Geranium ibericum—1.5′ HT, violet-blue flowers with purple veins in early summer, hairy deeply cut leaves, red fall color. 37, 95, 139

Geranium 'New Hampshire'—6″ HT, purple flowers. 137

Geranium palmatum (anemonifolium)—1.5′ HT, rosy-pink flowers in late spring, finely divided leaves, tender. 175

Geranium platypetalum—1′ HT, violet flowers with blue veins in early summer, deeply cut green leaves. 9, 21, 27, 37, 65, 83, 97, 137, 143, 153, 165, 169

Geranium pratense—2′ HT, violet-blue flowers, deeply divided leaves, good red fall color. 52, 95, 97, 109, 137, 159

Geranium psilostemon—4′ HT, magenta flowers with a black eye in early summer, deeply cut broad leaves, good red fall color. 83

Geranium pylzowianum—3″ HT, deep rose-pink flowers with a greenish center, leaves finely dissected, trough or rock garden plant. 95

Geranium renardii—1′ HT, opal-white veined with violet flowers in early summer, leaves sage-green deeply veined, silvery silky beneath. 9, 29, 83, 133

Geranium richardsonii—3′ HT, pale pink flowers with purple veins, leaves deeply dissected. 61

Geranium sanguineum—1′ HT, magenta flowers in early summer, dark green deeply cleft leaves. 3, 29, 37, 49, 52, 63, 65, 83, 95, 97, 107, 137, 139, 143, 153, 169, 171, 177, 183

'Album'—1.5′ HT, pure white flowers. 9, 29, 37, 49, 65, 77, 83, 91, 95, 107, 121, 137, 139, 145, 153, 159, 165

'Alpinum Superbum'—8″ HT, rose-red flowers. 95

'Alpenglo'—6″ HT, rich magenta flowers, compact habit. 49, 133, 145

'Cedric Morris'—1.5′ HT, rose-magenta flowers, vigorous cultivar. 34

'Glenluce'—1.5′ HT, clear pink flowers. 34

'Nanum'—2″ HT, rose-magenta flowers. 34

prostratum (*lancastrense* and 'Striatum')—light pink flowers with crimson veins, small divided leaves. 3, 21, 27, 29, 34, 37, 49, 65, 67, 77, 83, 107, 137, 139, 145, 153, 159, 165, 171, 177, 183

'Purple Flame'—similar to species. 137

Geranium sessiliflorum 'Nigrum'—3″ HT, white flowers, soft brown rosettes of leaves. 34, 144

Geranium wallichianum 'Buxton's Blue'—1′ HT, blue flowers with white centers in summer, deeply cut lobed leaves. 161

Geum: all prefer moist well drained soil and bloom in late spring, leaves are toothed, green, rounded and hairy, good groundcover plant.

Geum x *borisii*—10″ HT, dark orange flowers. 37, 49, 65, 77, 83, 91, 95, 97, 137, 153, 159, 161, 171

Geum 'Coppertone'—1′ HT, pale apricot flowers. 34

Geum 'Georgenberg'—1′ HT, deep yellow flowers. 65, 77, 95, 153

Geum 'Lionel Cox'—1′ HT, drooping creamy yellow flowers, dark green hairy leaves. 34, 49

Geum macrophyllym—1′ HT, yellow small flowers, large rounded leaves. 5

Geum montanum—6″ HT, bright yellow flowers, feathery seed heads, alpine plant. 3, 29, 139, 145, 159, 161

'Heldreichii'—10″ HT, double orange-red flowers. 37, 65, 153

Geum 'Princess Juliana'—1.5′ HT, bright double orange flowers. 65, 153, 159

Geum quellyon (chilense and *coccineum)* 'Dolly North'—1.5′ HT, yellow-orange flowers. 37, 159

'Feuermeer'—bright red-flowers. 37, 65, 153

'Fire Opal' ('Feuerball')—14″ HT, bright red flowers. 27, 52, 65, 95, 153, 159

'Lady Stratheden'—2′ HT, double yellow flowers. 9, 21, 37, 39, 49, 65, 95, 107, 153, 159, 161, 165, 183

'Mrs. Bradshaw'—2′ HT, double bright brick-red flowers. 9, 21, 33, 37, 39, 49, 61, 65, 95, 97, 107, 115, 139, 153, 159, 161, 165, 183

Geum 'Red Wings'—1.5′ HT, red flowers. 9

Geum reptans (Sieversia reptans)—6″ HT, yellow flowers, stoloniferous. 37, 49, 65, 137, 139, 153, 165

Geum rivale—1′ HT, 49, 159

'Leonard's Variety'—1′ HT, nodding double coppery-rose flowers. 37, 65, 95, 153

Geum 'Starkers Magnificum'—1.5′ HT, double orange flowers. 34, 65, 153

Geum triflorum—1′ HT, purplish flowers in spring, deeply cut leaves, feathery pink and silver seed heads. 61, 127

Geum urbanum—1′ HT, yellow flowers. 161

Geum 'Wright's Hybrid'—10″ HT, orange flowers. 3

Glaucium flavum—3′ HT, golden yellow-orange flowers in summer, silver-gray lobed leaves, requires good drainage. 52, 109, 161

Globularia bellidifolia—6″ HT, powder-blue pom-pom flowers in early summer, shiny narrow green leaves. 133

Globularia cordifolia—5″ HT, powder-blue heads in early summer, dark green heart-shaped mat-forming leaves. 3, 95, 145

nana—4″ HT, similar to species but forms denser mats, leaves narrower. 144

Globularia incanescens—4″ HT, powder-blue heads in early summer, leaves round blue-green. 121

Globularia meridionalis—4″ HT, rich blue

heads in early summer, more tufted than mat-forming. 95, 133, 145

Globularia nudicaulis—10″ HT, blue flowers in early summer, roundish long leaves, requires good drainage. 3

Globularia trichosantha—9″ HT, brilliant blue flowers in early summer, densely packed rich green leaves, good groundcover, requires good drainage. 145

***Goniolimon** tataricum (Limonium tatarica)*—1.5′ HT, small white to pink flowers similar to "Baby's Breath," leathery green lance-shaped leaves. 9, 21, 33, 37, 65, 67, 69, 83, 107, 153, 159, 165, 169, 171, 183

***Gratiola** officinalis*—10″ HT, rose flowers. 52

Gypsophila: All require good drainage and bloom in summer.

Gypsophila aretioides–3″ HT, white flowers, tiny tufted leaves. 133

Gypsophila cerastioides–2″ HT, pale pink flowers, small green rounded leaves. 77, 133, 145

Gypsophila nana—2″ HT, pink flowers, succulent and tufted leaves. 133

Gypsophila oldhamiana—2′ HT, pink flowers, lance-shaped leaves. 49, 173

Gypsophila pacifica—3′ HT, pale rose or purple flowers, succulent oval leaves. 33, 137

Gypsophila paniculata—4′ HT, tiny white stars in summer, small gray leaves. 63, 115

'Bristol Fairy'—4′ HT, pure white double flowers. 9, 37, 49, 63, 65, 77, 83, 95, 97, 107, 137, 153, 159, 165, 167, 169, 171, 175, 177

'Compacta Plena'—3′ HT, double white flowers. 37, 65, 153

'Double Snowflake'—3′ HT, double white flowers. 52, 175, 183

'Early Snowball'—3′ HT, double white flowers. 27

'Flamingo'—3′ HT, double pink flowers. 9, 37, 83, 167

'Pacific Pink'—52

'Perfecta'—3′ HT, double white flowers twice the size of 'Bristol Fairy.' 21, 37, 49, 63, 65, 83, 95, 153, 159, 167, 169, 171, 175, 177

'Pink Fairy'—1.5′ HT, double clear pink flowers. 21, 37, 39, 49, 65, 83, 95, 97, 107, 121, 137, 153, 165, 171

'Pink Star'—49

'Red Fox'—49

'Red Sea'—2.5′ HT, small deep pink flowers. 159, 169

'Snowflake'—3′ HT, double white flowers. 75, 83, 137, 161, 169

'Virgo'—3′ HT, semidouble white flowers. 3, 161

'Viette's Dwarf'—15″ HT, double pink flowers. 9, 27, 37, 77, 159

Gypsophila petraea—8″ HT, white flowers in summer, silver green mat-forming leaves. 98

Gypsophila repens—10″ HT, white-lilac flowers, mat forming. 3, 33, 52, 97, 144, 161, 167

'Alba'—10″ HT, white flowers. 37, 49, 65, 107, 153, 159, 177

'Bodgeri'—10″ HT, double pink flowers. 95

'Dorothy Teacher'—4″ HT, pink flowers. 21, 65, 153

'Dubia'—4″ HT, deep pink flowers. 37

'Monstrosa'—137

'Rosea'—6″ HT, tiny rose pink flowers, leaves gray dense mats. 3, 21, 33, 37, 65, 83, 97, 107, 133, 137, 145, 153, 159, 161, 169, 177, 183

Gypsophila tenuifolia—8″ HT, wiry stems of white, tight tufted grassy leaves. 133, 145

***Haplopappus** glutinosus*—4″ HT, yellow daisies in late summer, rich green mats of leaves. 61, 133

***Hedyotis** caerulea (Houstonia caerulea)*—4″ HT, deep blue flowers with a yellow eye in

spring, tufted semievergreen leaves, requires moist soil. 9, 21, 49, 77, 83, 133, 137, 144, 173

Hedyotis michauxii (Houstonia serphyllifolia)—4″ HT, deep blue flowers, similar to *H. caerulea*, but stems lay flat and root. 9, 66, 173

'Alba' (*procumbens*)—white flowers. 54

Hedyotis purpurea (Houstonia purpurea)—1′ HT, pale purple or lilac flowers in early summer, broad leaves. 54, 66, 144, 173

longifolia (Houstonia longifolia)—10″ HT, white and lavender flowers, lance-shaped leaves. 54, 173

Helenium autumnale—5′ HT, yellow or orange flowers with a brown center in late summer, narrow green leaves, requires moist soil. 37, 49, 61, 66, 115, 177

'Brilliant'—3′ HT, rust and yellow flowers. 177

'Bruno'—3′ HT, warm brown flowers. 45

'Butterpat'—3′ HT, clear yellow flowers. 177

'Copper Spray'—1′ HT, coppery-red flowers. 34

'Crimson Beauty'—4′ HT, carmine-red flowers. 9, 83, 95

'Gartensonne'—5′ HT, bright golden-yellow flowers. 34, 95

'Moerheim Beauty'—4.5′ HT, rich bronze-red flowers fading to orange-brown. 9, 27, 34, 39, 165

'Pumilum Magnificum'—3′ HT, pale yellow flowers. 9, 83

'Redgold'—3-4′ HT, mixed colors. 3, 107

'Riverton'—4.5′ HT, yellow flowers. 39, 65, 153, 165, 177

'Waldtraut'—4.5′ HT, tawny-orange flowers. 3, 34

Helenium bigelovii—2′ HT, deep orange flowers tinted with yellow and a brown center in summer, shiny green leaves. 49, 61

Helenium hoopesii—3′ HT, yellow flowers with a brown center. 39, 49, 52, 65, 83, 153, 161

Helianthemum: require good drainage and full sun, are evergreen and bloom in early summer.

Helianthemum apenninum roseum (H. rhodanthum 'Carneum' and *H.* 'Wisley Pink')—10″ HT, clear pink flowers, small gray leaves, trailing stems. 21, 34, 37, 49, 159, 183

Helianthemum nummularium (vulgare)—10″ HT, yellow flowers, green leaves, gray tomentose beneath. 3, 61, 98

'Amy Baring'—6″ HT, bright apricot-yellow flowers. 95

'Ben More'—orange-red flowers with a carmine center. 83

'Ben Nevis'—tawny golden-orange flowers. 37, 159

'Boule de Feu'—double crimson-red flowers. 95

'Brown Gold'—yellow flowers with brown overtones. 37, 159

'Cerise Queen'—cerise-red flowers. 83, 159

'Dazzler'—bright deep crimson-red flowers. 34, 37, 95

'Double Apricot'—double apricot flowers. 37, 49, 65, 95, 97, 137, 153

'Double Cerise'—double cerise-red flowers. 9

'Double Orange'—6″ HT, semidouble orange flowers. 37, 49, 65, 95, 97, 137, 153

'Double Red'—double red flowers. 9, 37, 65, 153, 159

'Double Yellow'—small double yellow flowers. 9, 49, 137

'Fire Ball' ('Mrs. Earle')—6″ HT, double red flowers. 37, 83, 159

'Fire Dragon' ('Mrs. Clay')—coppery-red flowers, gray-green leaves. 9, 37, 159, 177

'Flame'—single pink flowers. 37, 95, 183

'Golden Nugget'—2″ HT, golden-yellow flowers. 95

'Golden Queen' ('Yellow Queen')—golden-yellow flowers. 83

'Henfield Brilliant'—large bright copper flowers. 34, 37, 95

'Jubilee'—6″ HT, double lemon flowers. 37, 159

'Lox Beard Gold'—large golden-apricot flowers with a buttercup center. 95

'Mikes' Mix'—mixed colors. 52

'Mrs. Mold'—6″ HT, deep bronze flowers shaded with salmon, fringed petals. 34, 95

'Mutabile'—flowers changing to lilac or nearly white. 3

'Orange Surprise'—6″ HT, golden-orange flowers with a dark orange center. 145

'Peach'—large apricot-peach flowers. 37, 133, 183

'Pink'—pink flowers. 133

'Praecox'—yellow flowers in late spring, gray leaves. 37

'Pumpkin'—bright orange flowers. 37, 183

'Raspberry Ripple'—double raspberry-red and white flowers, gray leaves. 37, 95, 137

'Rose Queen'—rose-pink flowers. 37, 159

'Seattle'—large bright copper flowers. 95

'St. Mary's'—white flowers, green leaves. 34, 37, 65, 95, 97, 153, 159, 177, 183

'Sun Fleck'—double bright golden-yellow flowers. 37, 65, 95, 133, 153

'Wisley Primrose'—large soft yellow flowers. 34, 37, 77, 95, 133, 159, 183

Helianthus *angustifolius*—7′ HT, bright yellow flowers with purple-brown center in fall, long narrow shiny leaves, requires moist to wet soil. 9, 37, 77, 83, 91, 109, 113, 115, 117, 157, 173

Helianthus atrorubens—2′ HT, bright yellow flowers with a deep red-purple center in late summer, clustered rosettes of leaves, rhizomatous, invasive. 113, 115, 117, 157, 173

Helianthus giganteus—10′ HT, yellow flowers in summer, coarse green leaves, rhizomatous, invasive. 49, 120, 181

Helianthus maximiliani—8′ HT, bright yellow flowers in late summer, coarse gray-green leaves. 113, 117, 120, 165

Helianthus mollis—5′ HT, butter-yellow flowers in summer, hairy coarse leaves, rhizomatous, requires dry soil. 127

Helianthus x *multiflorus*—6′ HT, yellow flowers in late summer, coarse green leaves.

'Flora Pleno'—double flowers. 9, 37, 49, 65, 83, 153, 165, 177

'Loddon Gold'—4.5′ HT, double bright golden-yellow flowers. 37, 65, 95, 153, 159

Helianthus occidentalis—5′ HT, bright yellow starlike flowers in late summer, rhizomatous, requires dry soils. 127

Helianthus salicifolius—6′ HT, bright golden-yellow flowers with brown center in fall, narrow dark green leaves, requires dry soils. 9, 37, 65, 91, 153

Helichrysum *frigidum*—2″ HT, thin petaled yellow daisies in summer, silvery woolly leaves. 145

Helichrysum selago—8″ HT, leaves green and white woolly with rigid stems. 145

Heliopsis *helianthoides*—5′ HT, yellow semi-double flowers in summer, leaves green and serrated. 52, 107, 127, 161, 181

'Danegold'—4′ HT, golden-yellow flowers. 144

'Goldfeather'—3′ HT, double yellow flowers. 9

'Gold Greenheart'—3′ HT, golden-yellow flowers. 9, 29, 65, 83, 153

'Golden Plume'—3′ HT, double bright yellow flowers. 9, 65, 153, 177

'Goldquelle'—5′ HT, yellow-orange flowers. 83

'Incomparabilis'—4′ HT, double golden-yellow flowers. 65, 153

'Karat'—4′ HT, golden-yellow flowers. 159

'New Hybrids'—4′ HT, gold flowers. 3, 159, 161

'Patula'—4′ HT, semidouble flowers. 29, 83, 159

scabra—4′ HT, yellow-orange flowers. 21, 33, 37, 75

'Summer Sun'—4′ HT, semidouble golden-yellow flowers. 3, 9, 27, 29, 37, 39, 45, 49, 65, 95, 107, 133, 153, 153, 161, 165, 169, 175, 177, 183

Heracleum mantegazzianum—8′ HT, white flat-topped clusters of flowers to 4′ across in summer, large divided green leaves, tolerates partial shade, requires moist soil, biennial. 49, 52, 91, 161

Herniaria glabra—2″ HT, small green flowers in summer, mosslike leaves, semievergreen. 9, 33, 49, 65, 91, 97, 133, 153, 159

Hesperaloe parviflora—2′ HT, spikes of bright pink and yellow bells to 5′ HT in summer, narrow straplike rosettes of leaves, evergreen, requires good drainage. 61

Hesperis matronalis—3.5′ HT, white to deep lilac fragrant flowers in early summer, lance-shaped coarse leaves. 33, 63, 107, 123

Heuchera americana—1.5′ HT, greenish-white flowers, broad lobed dark green leaves flushed with coppery brown. 9, 41, 49, 66, 77, 113, 139, 141, 157, 173, 181

'Tellico'—selection with mottled foliage flushed with coppery brown. 113, 144

Heuchera* x *brizoides—sprays of small pink to white bells, scalloped leaves turning red in fall, will grow in full sun or partial shade.

'Oakington Jewel'—2.5′ HT, coral-red flowers, bronze marbled leaves. 65, 153

'Red Spangles'—2′ HT, deep red flowers, white inside. 39

Heuchera cylindrica glabella—8″ HT, cream flowers in summer, scalloped green leaves. 'Greenfinch'—3′ HT, creamy green flowers, dark heart-shaped leaves. 34, 95

'Siskiyou Mountains'—dwarf. 145

Heuchera hallii—1′ HT, small greenish white flowers in early summer, small tufted green leaves. 145

Heuchera micrantha—2′ HT, white flowers in early summer, green leaves with white hairs.

'Palace Purple'—1.5′ HT, white flowers, ivy-shaped mahogany red leaves above, beet red below. 9, 29, 34, 45, 77, 109, 122, 159, 169, 171

Heuchera 'Pluie de Feu'—2′ HT, bright red flowers. 9, 29, 37, 65, 83, 95, 133, 137, 159, 165, 177

Heuchera richardsonii—3′ HT, greenish white flowers in early summer, dark green ivylike leaves. 107, 113, 127, 159, 173

Heuchera rubescens alpicola—1′ HT, light pink flowers in early summer, small scalloped evergreen leaves. 49

Heuchera sanguinea—1.5′ HT, bright red flowers in early summer, rounded lobed leaves, reddish fall color, will grow in full sun or partial shade, requires good moist soil. 9, 29, 52, 63, 67, 97, 139, 169, 177, 183

'Alba'—white flowers. 97

'Bressingham Hybrids'—2′ HT, light pink to dark red flowers. 3, 21, 27, 33, 37, 49, 52, 63, 65, 77, 83, 95, 115, 153, 157, 159, 161

'Carmen'—rich velvety mahogany flowers. 95

'Chartreuse'—chartreuse flowers. 37, 95

'Chatterbox'—pink flowers. 9, 29, 37, 52, 65, 95, 133, 137, 143, 153, 159, 165, 169

'Coral Cloud'—coral-pink flowers. 37, 65, 143, 153, 159, 169

'Coral Mist'—small coral flowers. 95

'Crimson Beauty'—crimson flowers. 9, 37

'Fire Bird'—deep rose-red flowers. 9, 37, 83, 159

'Firebright'—bright red flowers. 3

'Firefly'—8″ HT, scarlet flowers. 133

'Firesprite'—bright firey-red flowers. 37, 95

'Freedom'—bright rose-pink flowers. 29, 37, 95

'Glow Worm'—dark red flowers. 3

'Green Ivory'—2.5′ HT, yellowish-white flowers with a green base. 159, 171

'Huntsman'—red flowers. 9, 29

'Jubilee'—soft pink flowers. 29

'June Bride'—white flowers. 29, 37, 63, 159, 171

'Matin Bells'—coral-red flowers. 9, 65, 171

'Maxima'—deep crimson flowers. 121

'Mt. St. Helens'—bright blood-red flowers. 171

'Patricia Louise'—2′ HT, bright pink flowers. 37

'Pretty Polly'—1′ HT, pink flowers. 37, 159

'Queen of Hearts'—bright fiery-red flowers. 65, 122, 153, 171

'Red Prince'—rich red flowers. 95

'Rosamundi'—coral-pink flowers. 133, 137, 153

'Snowflake'—pure white flowers. 95

'Spitfire'—red flowers. 9, 133, 137

'Splendens'—2.5′ HT, bright scarlet-red flowers. 21, 29, 37, 159

'Tattletale'—2′ HT, pink flowers. 159

'White Cloud'—white flowers. 9, 29, 37, 39, 65, 83, 133, 137, 143, 153, 159, 169

Heuchera 'Scarlet Sentinel'—2′ HT, red flowers. 9

Heuchera versicolor—2′ HT, deep pink buds with white flowers. 181

Heuchera villosa—1.5′ HT, small white flowers in early summer, large palmate leaves, will grow in full sun or partial shade. 54, 66, 157, 173, 181

macrorhiza—white flowers, large fuzzy leaves. 181

'Purpurea'—2′ HT, white flowers, deep purple maple-shaped leaves supposedly darker than 'Palace Purple.' 49, 133, 137

Heucherella *tiarelloides* 'Bridget Bloom'—1.5′ HT, pink flowers in summer, small ivy-shaped mottled leaves. 9, 29, 37, 39, 61, 83, 91, 143

Hibiscus *coccineus*—7′ HT, brilliant scarlet flowers in late summer, bluish green deeply lobed leaves, requires moist soil. 9, 41, 49, 181

Hibiscus 'Disco Belle Red'—2′ HT, large red flowers in summer, large coarse heart-shaped leaves. 49, 175

Hibiscus 'Disco Belle White'—2′ HT, white flowers with a red center in summer. 49, 175

Hibiscus 'Frisbee Mix'—2′ HT, mixed shades of red, pink and white flowers in summer. 49, 52, 175

Hibiscus furcellatus—8′ HT, pink flowers with a red base in summer, coarse dissected leaves, requires moist soil, tender. 181

Hibiscus grandiflorus—similar to *H. moscheutos*, tender. 181

Hibiscus militaris—6′ HT, pink flowers with a purple eye in summer, coarse lobed leaves, requires moist soil. 49, 113, 181

Hibiscus moscheutos—7′ HT, large white rose and pink flowers in midsummer, requires full sun and moist soil. 49, 52, 61, 113, 115, 117, 157, 159, 181

'Ann Arundel'—5′ HT, glowing lavender-pink flowers with a dark center. 171

'Clown'—4′ HT, soft pink flowers with fuchsia veins and a dark center. 37

'Crimson Wonder'—4′ HT, rich red ruffled flowers. 9, 37

'Giant Maroon'—4′ HT, deep maroon-red flowers. 37

'Lady Baltimore'—4′ HT, pink flowers with a cherry center. 171

'Lester Regal'—4′ HT, medium pink flowers with a red center and deep pink veins. 37

'Lord Baltimore'—5′ HT, brilliant crimson ruffled flowers. 9, 37, 159

'Mallow Marvels'—4′ HT, pink and white flowers. 65, 153, 169

palustris—6′ HT, white or pink flowers with a deep crimson center. 173, 181

'Pink Giant'—3.5′ HT, pale pink flowers with a red center. 9, 37

'Poinsettia'—5′ HT, red flowers. 9

'Radiation'—5′ HT, pink flowers. 9

'Satan'—5′ HT, deep red flowers. 9

'Silver Rose'—5′ HT, pink flowers. 9

'Snow Queen'—4′ HT, white flowers with a red center. 37

'Southern Belle Mix'—3′ HT, large flowers in shades of red, pink and white. 33, 49, 52, 65, 115, 122, 153, 159, 169, 171, 175

'Southern Belle Red'—5′ HT, large red flowers. 165

'Southern Belle White'—5′ HT, large white flowers. 165

'Super Rose'—3′ HT, pastel pink flowers with deep pink veins with a red center. 37

'White Beauty'—4′ HT, pure white flowers with a dark red eye. 37

'White Giant'—5′ HT, white flowers with a tinge of blush. 9

Hibiscus mutabilis—8′ HT, pure white flowers fading to crimson in fall, soft maplelike leaves, tender. 41

Hibiscus 'New River White'—5′ HT, pure white flowers. 9

Hieracium lanatum—2′ HT, yellow daisy flowers in summer, silvery gray woolly leaves, requires good drainage. 144

Hieracium maculatum—1.5′ HT, yellow daisy flowers in late summer, gray hairy purple-spotted leaves. 61

Hieracium villosum—1′ HT, large bright yellow dandelion flowers in summer, mats of gray woolly leaves. 144

Houttuynia cordata—1.5′ HT, white flowers with conelike centers in summer, heart shaped dark green leaves, invasive, requires moist to wet soils. 9, 98, 144

'Flore Pleno' ('Multiplex')—double flowers. 21, 34, 49, 54

'Variegata' ('Chameleon')—leaves variegated with red, cream and pink. 21, 34, 49, 61, 65, 67, 95, 98, 153, 171, 173, 181

Humulus lupulus—climbing vine to 20′ HT, green flowers, lobed green leaves, panicles of fragrant seeds. 69

Hydrocotyle peduncularis—2″ HT, white inconspicuous flowers, small round scalloped leaves, stoloniferous, invasive, requires moist soil and will tolerate partial shade. 121

Hymenoxys acaulis glabra (Actinea herbacea)—1′ HT, large yellow daisies in early summer, grasslike mats of leaves, requires good drainage. 25, 133, 145

Hypericum: all require well drained soil and have golden-yellow flowers with a central "boss" of stamens.

Hypericum ascyron—5′ HT, small yellow flowers on bushy plants. 120, 127, 173

Hypericum calycinum—1.5′ HT, golden-yellow flowers in early summer, green oval leaves, invasive, tolerates dry shade. 21, 52, 65, 67, 107, 159, 169, 183

Hypericum cerastoides—6″ HT, golden-yellow flowers in summer, hairy gray leaves. 133, 145

Hypericum formosum—1′ HT, blooms in summer, soft bluish-green leaves, rhizomatous. 5

Hypericum olympicum (polyphyllum)—8″ HT, small bright yellow flowers in summer, small gray-green leaves of trailing mats. 52, 77, 107

grandiflorum - larger flowers. 153

Hypericum patulum 'Hidcote'—2′ HT, butter-yellow flowers in early summer, dark green oval leaves with a citrus odor, tolerates light shade. 21, 67

Hypericum perforatum—2.5′ HT, small yellow flowers in summer, narrow blue-green leaves. 83, 183

Hypericum punctatum—4′ HT, small yellow flowers in summer, oblong rounded leaves. 183

Hypericum reptans—6″ HT, large yellow flowers in summer, small blue-gray leaves on wiry stems. 65, 97, 133, 153

***Hypsela** reniformis*—1″ HT, pale pink flowers with crimson stripes, matted leaves. 145

***Iberis** gibraltarica*—1′ HT, lilac flowers with white centers in spring, shiny, toothed, evergreen rosettes of leaves. 37, 161

Iberis pruitii (candolleana)—2″ HT, white flowers in spring, fleshy green mats of leaves. 145

Iberis saxatilis—3″ HT, white flowers in spring, slender evergreen mats of leaves. 3, 95, 159, 161

Iberis sayana—2″ HT, white flowers in spring and fall, dense evergreen mats of leaves. 133, 145

Iberis sempervirens—1′ HT, white flowers in spring, evergreen dark green leaves. 5, 35, 37, 49, 52, 67, 75, 91, 97, 115, 137, 153, 157, 161, 169, 175

'Alexander's White'—10″ HT, white flowers, dense compact habit. 9, 77, 159, 169

'Autumn Beauty' ('Autumn Snow')—8″ HT, white flowers in spring and fall. 9, 37, 65, 95, 107, 153, 159, 165, 175, 177, 183

'Bluemount Snow'—10″ HT, white flowers blooming earlier than species. 21, 37

'Kingwood Compact'—8″ HT, white flowers, compact habit. 37

'Little Gem'—6″ HT, dwarf form. 9, 37, 65, 133, 137, 153, 159, 183

'October Glory'—8″ HT, blooms in spring and fall. 137, 169

'Purity'—8″ HT, compact form. 27, 37, 49, 107, 153, 165, 177, 183

'Pygmaea'—5″ HT, compact form. 9, 37, 49, 133, 153, 159, 177

'Snowflake'—8″ HT, large white flowers. 3, 9, 21, 37, 65, 95, 133, 153, 159, 161, 165, 169, 171

'Snowmantle'—8″ HT, large white flowers. 37, 159, 183

***Incarvillea** delavayi*—2′ HT, rose-red flowers in early summer, deeply divided leaves, decorative seed pods, requires moist well-drained soil. 9, 61, 95, 133, 139, 159, 161, 169

Incarvillea mairei (grandiflora)—1′ HT, similar to *I. delavayi* only shorter. 159

***Inula** ensifolia*—1′ HT, yellow daisies in late summer, small narrow gray-green leaves, requires well-drained soil. 49, 52, 61, 65, 95, 107, 153, 161, 165, 177

'Compacta'—8″ HT, compact form of species. 37

Inula hirta—1.5′ HT, yellow daisies in summer, lance-shaped leaves. 52, 161

Inula magnifica—6′ HT, deep yellow flowers with thin petals in late summer, coarse hairy green leaves, requires moist to wet soils. 49, 52, 91, 165

Inula orientalis—2′ HT, orange-yellow lacy daisies in midsummer. 83, 95, 107

Ipomopsis rubra (Gilia rubra)—6′ HT, scarlet flowers outside, yellow with red dots on the inside in summer, finely cut threadlike leaves, short-lived perennial. 117, 121

Jasione *heldreichii*—1′ HT, rounded heads of small blue bells in spring, tufted leaves, requires good drainage. 61

Jasione perennis (laevis)—1.5′ HT, steel-blue flowers in rounded heads in spring, oblong lance-shaped hairy leaves. 49, 52, 83, 159, 161, 175

Kitaibelia *vitifolia*—5′ HT, brown-black dry flowers outside, white hairy inside, coarsely toothed and lobed leaves. 52

Knautia *macedonica*—2′ HT, crimson pincushion flowers in summer, basal compound leaves. 159

Kniphofia: all have pokerlike flowers and narrow grasslike leaves, require moist well-drained soil.

Kniphofia 'Empress of India'—4′ HT, deep scarlet flowers. 34

Kniphofia galpinii—3′ HT, saffron-orange flowers. 173

Kniphofia 'Glow' ('Coral Sea')—2.5′ HT, coral-red to deep rose flowers in early summer. 34, 37

Kniphofia 'Gold Mine'—3′ HT, golden amber-yellow flowers. 34, 37

Kniphofia 'Jonkheer Van Tets'—3′ HT, bright orange flowers in midsummer. 37

Kniphofia 'Little Maid'—2.5′ HT, creamy white flowers in late summer to fall. 34, 37

Kniphofia 'Parmentier'—3′ HT, salmon flowers in summer. 37

Kniphofia 'Wayside Flame' ('Pfitzeri')—3′ HT, deep orange-red flowers in fall. 9, 21, 37, 97, 169, 171, 175

Kniphofia 'Royal Standard'—4′ HT, red and yellow flowers in summer. 9, 83, 165

Kniphofia 'Shenandoah'—3′ HT, yellow and orange flowers in summer. 9

Kniphofia 'The Rocket'—3′ HT, coral-red flowers in fall. 37

Kniphofia uvaria—4′ HT, red flowers in fall. 91, 117

'Alcazar'—2.5′ HT, coral-red flowers in summer. 37

'Earliest of All'—2.5′ HT, coral-rose flowers in early summer. 37

'Early Hybrids'—2.5′ HT, orange to red flowers in early summer. 169

'Express'—3′ HT, orange flowers in summer. 3

'Flame'—3′ HT, flame-red flowers in fall. 159

'Primrose Beauty'—2.5′ HT, primrose-yellow flowers in early summer. 37, 95, 169

'Royal Castle Hybrids'—3′ HT, yellow to orange flowers. 159

'Royal Standard'—4′ HT, red and yellow flowers in summer. 9, 83, 165

'Vanilla'—2.5′ HT, cream flowers in early summer. 9, 37, 65, 153, 165

Kniphofia 'White Fairy'—3′ HT, creamy white flowers. 37, 65, 153

Krigia *montana*—1′ HT, bright yellow dandelionlike flowers in summer, gray-green basal leaves, requires full sun. 173

Lachnanthes *caroliana*—2′ HT, white fuzzy flowers in late summer, irislike leaves, rhizomatous, requires moist to wet soils. 173

Lathyrus *latifolius*—8′ HT, climbing vine, pink, red or white pealike flowers in summer,

dark green pealike leaflets. 3, 75, 83, 97, 107, 137, 169, 177

'Pink Pearl'—pink flowers. 161

'White Pearl'—white flowers. 161

Lathyrus vernus—15″ HT, purple pealike flowers in spring, fernlike divided leaves disappearing by midsummer, requires well-drained soils. 3, 9, 37, 54, 161, 173

Lavatera thuringiaca—5′ HT, pink mallow flowers in summer, soft hairy lobed sage-green leaves. 107, 159

Leontopodium alpinum—8″ HT, starlike yellow woolly bracts in summer, thin silver woolly leaves, requires well-drained gritty soil, short-lived perennial. 3, 21, 52, 61, 75, 83, 95, 107, 133, 139, 159, 161, 165, 177, 183

'Migon'—6″ HT, compact form. 95

Leontopodium palibinianum—16″ HT, starlike yellow woolly bracts, silver woolly leaves, requires well-drained gritty soil. 3, 52

Leontopodium souliei—16″ HT, similar to *L. palibinianum*, but stoloniferous. 3, 161

Lespedeza capitata—4′ HT, white pealike flowers in late summer, silvery bronze fall color, requires well drained soil. 127

Lewisia nevadensis—2″ HT, white flowers in early summer, needlelike basal leaves, requires dry summer conditions. 145

Lewisia oppositifolia—8″ HT, white or pink flowers in spring, thin basal leaves, requires dry summer conditions. 145

Lewisia 'Pinkie'—8″ HT, pink flowers in spring, narrow rosettes of leaves. 145

Lewisia rediviva—2″ HT, rose flowers in early summer, fleshy needlelike leaves, requires dry summer conditions. 33

Liatris: require well-drained soil, bloom in summer and have grasslike tufts of leaves.

Liatris aspera—3′ HT, mauve spikes in late summer, grasslike tufts of leaves. 107, 115, 120, 127, 159

Liatris cylindracea—2′ HT, lavender flowers. 107, 127, 159

Liatris graminifolia—3′ HT, lavender flower spikes in late summer. 117, 173

Liatris punctata—2′ HT, rose-purple flowers. 45

Liatris pycnostachya—4′ HT, mauve flowers. 25, 29, 37, 61, 65, 66, 95, 107, 113, 115, 127, 153, 157, 165, 173, 177, 183

'Alba'—white flowers. 9, 39, 65, 107, 153, 165, 169, 183

'Blazing Star'—3′ HT, bright purple flowers. 63, 165

Liatris scariosa—3′ HT, purple flowers. 29, 45, 66

'Alba'—4′ HT, white flowers in late summer. 37, 63, 171

'September Glory'—4′ HT, purple flowers in late summer. 9, 65, 95, 153, 159

'White Spire'—4′ HT, white flowers. 9, 27, 29, 95, 153, 159, 177

Liatris 'Snow White'—3′ HT, white flowers. 165

Liatris spicata—4′ HT, mauve flowers. 9, 21, 37, 45, 49, 65, 66, 77, 83, 115, 117, 123, 133, 137, 157, 165, 173, 175, 181

'Alba'—white flowers. 61, 83

'Floristan'—4′ HT, pure white flowers. 3, 33, 52, 65, 159, 173, 175

'Kobold'—2′ HT, brilliant mauve-pink flowers. 3, 9, 25, 29, 33, 37, 61, 67, 83, 95, 107, 109, 122, 137, 153, 159, 169, 171, 177

'Resinosa'—purple loose spikes in late summer. 173

'Silvertips'—2′ HT, white flowers. 29, 65

Liatris squarrosa (earlei)—2.5′ HT, short spikes of purple flowers. 117, 173

Limonium bellidifolium (caspium)—10″ HT, lilac sprays of flowers in summer, oval evergreen leaves, requires well drained soil. 145

'Filigree'—159, 161

Limonium *gmelinii*—2′ HT, lilac sprays in summer, oval basal leaves. 52, 161

Limonium latifolium—1.5′ HT, blue sprays in summer, semievergreen large leathery leaves, requires well drained soil. 9, 49, 52, 63, 65, 69, 77, 83, 95, 97, 107, 137, 153, 159, 165, 169, 171

'Violetta'—violet-blue flowers. 9

Limonium minutum—6″ HT, small purple sprays, oval basal leaves, requires well drained soil, good for trough gardens or scree. 145

Limonium perezii—1.5′ HT, blue sprays in summer, oval basal leaves, tender. 159, 161

Linaria *alpina*—6″ HT, blue-violet flowers with orange markings in summer, tufted glaucous leaves. 3, 65, 121

Linaria genistifolia—3′ HT, yellow flowers with orange markings in summer, linear gray-green leaves. 61

dalmatica—wider leaves. 52

Linaria purpurea—3′ HT, lilac-purple flowers with orange markings in summer, gray-green whorled leaves, requires good drainage and sandy soil. 49

'Canon Went'—3′ HT, light pink flowers. 49, 65, 153, 159, 173

Linaria supina—9″ HT, pale yellow flowers in summer, linear whorled leaves on trailing stems. 65

Linaria vulgaris—2.5′ HT, yellow flowers with orange markings in summer, linear whorled gray-green leaves. 97, 123

Linum *altaicum* 'Khirgizia'—2′ HT, violet-blue flowers in summer, oblong tufts of leaves, requires good drainage. 11

Linum capitatum—1′ HT, dense heads of yellow flowers in summer, lance-shaped leaves. 133, 145

Linum flavum—1.5′ HT, waxy yellow flowers in summer, small linear leaves. 61, 97, 177

'Compactum'—10″ HT, compact form. 52, 65, 83, 107, 153, 159, 161

Linum hirsutum—1.5′ HT, clear pink flowers in early summer, lance-shaped leaves. 145

Linum narbonense—1.5′ HT, deep blue-azure flowers in summer, small gray-green narrow leaves. 37, 39, 52, 61, 65, 153

'Heavenly Blue'—1′ HT, compact form. 145, 153, 159

Linum perenne—2′ HT, pale azure-blue flowers in summer, gray-green leaves. 9, 21, 33, 49, 63, 77, 83, 97, 107, 109, 137, 139, 165, 177, 183

alpinum—10″ HT, compact form. 3, 52

'Diamond'—10″ HT, pure white flowers. 39, 49, 52, 65, 153, 159, 161, 165, 183

'Lewisii'—2′ HT, more vigorous, larger flowers. 5, 175

'Sapphire'—10″ HT, pale azure-blue flowers. 37, 49, 65, 107, 137, 153, 159, 165, 183

Linum suffruticosum 'Nanum'—2″ HT, large pearl white flowers veined with lilac in summer, linear leaves on a trailing stem, tender. 145

Lithodora *diffusa (Lithospermum diffusum)*—6″ HT, azure-blue flowers with reddish-violet markings, blooms in summer, leaves dark hairy and evergreen, requires acid moist organic soil and must be protected from afternoon sun. 3

'Grace Ward'—larger flowers. 145, 153

'Heavenly Blue'—3″ HT, more compact. 145

Lithospermum *caroliniense*—1′ HT, yellow flowers in summer, hairy linear leaves, requires good drainage. 127

Lobelia *cardinalis* 'Queen Victoria'—3.5′ HT, scarlet flowers in late summer, light green leaves, tender. 3, 159, 169, 175, 183

Lobelia x *gerardii (vedraiensis)*—3.5′ HT, purple flowers in late summer, requires moist to wet soils. 49, 65, 83, 109, 153, 159, 177

Lobelia cardinalis

Lobelia laxiflora—2′ HT, tubular red and yellow flowers in summer, narrow dark green leaves, tender. 34

Lobelia puberula—3′ HT, soft blue flowers in late summer, light green leaves, will grow in full sun or partial shade. 115, 117, 123, 173

Lobelia x *speciosa*—3′ HT, purple-violet flowers in summer, requires moist soil and will grow in full sun or partial shade. 'Oakes Ames'—scarlet flowers with deep green leaves tinged with burgundy. 177

'Wisley'—2.5′ HT, scarlet flowers, deep rich green leaves. 177

Lobelia splendens (fulgens)—3′ HT, scarlet flowers in late summer, lance-shaped leaves, requires moist soil. 33, 61

'Bee's Flame'—3.5′ HT, bright red flowers and leaves. 171

'Illuminations'—3′ HT, scarlet flowers, hairy dark green leaves. 65, 153

Lotus *corniculatus*—2′ HT, yellow pealike flowers tinged with red in early summer, green divided leaves on trailing stems.

'Flore Plena'—double yellow flowers. 9

tenuifolium—6″ HT, bright yellow flowers. 49

Lupinus *latifolius*—4′ HT, blue to purple flower spikes in spring. 5

Lupinus perennis—2′ HT, blue, purple flowers in early summer, deep green divided leaves. 52, 107, 127, 173

Lupinus polyphyllus—4′ HT, deep blue flowers in early summer. 61

Lupinus 'Russell Hybrids'—3′ HT, mixed colors in early summer. 9, 21, 27, 29, 33, 37, 39, 49, 65, 67, 75, 83, 95, 97, 122, 153, 159, 169, 171, 177, 183

'Chandelier'—3′ HT, yellow flowers. 52, 75, 97, 107, 159

'Chatelaine'—3′ HT, pink and white flowers. 52, 75, 107, 159

'Evening Glow'—3′ HT, red and yellow flowers. 107

'Gallery Mix'—3′ HT, mixed colors. 37, 159

'Gnome'—2′ HT, mixed colors. 169

'Minarette'—2′ HT, mixed colors. 3, 33, 37, 65, 75, 107, 137, 153, 159, 183

'My Castle'—3′ HT, brick-red flowers. 75, 107, 159

'Noble Maiden'—3′ HT, ivory and pure white flowers. 52, 75, 97, 107, 159

'Pink Popsicle'—1.5′ HT, glowing pink flowers on compact plants. 37

'Red Flame'—3′ HT, bright red flowers. 97

'The Governor'—3′ HT, marine-blue and white flowers. 37, 75, 97, 107, 159

'The Pages'—3′ HT, carmine-red shades. 52, 107, 159

Lychnis alpina—1′ HT, rose-purple or white flowers in early summer, tufted rosettes of leaves, requires moist fairly rich soil. 83, 161

Lychnis x *arkwrightii*—1.5′ HT, vivid orange-red flowers in midsummer, bronze-purple leaves, requires a moist rich soil. 171

Lychnis chalcedonica—3.5′ HT, vermilion flowers in summer, coarse green leaves, requires good soil. 33, 37, 39, 45, 49, 52, 63, 65, 77, 83, 95, 97, 107, 123, 153, 159, 161, 169, 173, 183

'Alba'—white flowers. 39, 65, 153

Lychnis coronaria—2.5′ HT, magenta flowers in summer, gray woolly leaves, prefers dry fertile soil. 37, 45, 49, 52, 54, 95, 98, 159, 161

'Alba'—white flowers. 37, 49, 52, 54, 159, 161

'Atrosanguinea' *(Agrostemma coronaria)*—dark red flowers. 83, 183

'Oculata'—white flowers with a cerise eye. 37

Lychnis flos-cuculi—2′ HT, lacy pink flowers in summer, green lance-shaped leaves, requires rich soil. 49, 161, 173, 183

Lychnis flos-jovis—1.5′ HT, reddish-pink flowers, gray woolly tufts of leaves. 49, 159, 161

Lychnis x *haageana*—1′ HT, large orange-red flowers in summer, hairy lance-shaped leaves. 3, 37, 49, 159, 161

Lychnis 'Vesuvius'—1.5′ HT, vivid orange-red flowers in midsummer, bronze-purple leaves. 3, 49, 159, 161

Lychnis viscaria (Viscaria vulgaris)—2′ HT, pink and purple flowers in early summer, grasslike tufted leaves, requires moist sandy soil. 3, 61, 159, 173

'Alba'—2′ HT, white flowers. 9, 37, 153

'Alpina'—4″ HT, rose-pink flowers. 3, 37, 49, 107, 183

'Flore Pleno'—1.5′ HT, double purple-red flowers. 9, 37, 49, 54, 65, 95, 153, 159, 183

'Snow'—1,5′ HT, pure white flowers. 159, 161

'Splendens Alba'—1.5′ HT, double white flowers. 83

'Zulu'—1.5′ HT, deep red flowers. 37, 95

Lysichiton americanum—2.5′ HT, yellow and green flowers in early spring, rich green paddle-shaped leaves, requires wet soils. 83, 145

Lysimachia ciliata—4′ HT, nodding clear light yellow star-shaped flowers in summer, smooth soft brown leaves turning to green, tolerates light shade, requires moist to wet soil. 34, 37, 49, 120, 173

Lysimachia clethroides—3′ HT, gray white arching spikes in late summer, green oval lance-shaped leaves turning red in fall, rhizomatous, invasive, prefers moist soils. 9, 21, 34, 37, 39, 49, 61, 65, 77, 83, 91, 107, 153, 159, 165, 169, 177, 183

Lysimachia nummularia—1″ HT, small yellow star-shaped flowers in summer, small round leaves on creeping stems that root, will grow in full sun or partial shade, requires moist to wet soil. 33, 91, 97, 133, 143, 169

Lysimachia punctata—3′ HT, star-shaped brassy yellow flowers, coarse hairy leaves turning red in fall, rhizomatous, invasive. 34, 39, 45, 49, 52, 61, 65, 75, 77, 83, 95, 107, 143, 153, 159, 169, 165, 173, 177

Lysimachia thyrsiflora—2.5′ HT, pale yellow flowers, lance-shaped leaves, requires moist soil. 66

Lythrum *salicaria*—4′ HT, magenta-pink flowers in summer, thin shiny green leaves turning red in fall, invasive, prefers moist to wet soils. 52, 69, 97

'Brightness'—3′ HT, pink flowers. 29

'Firecandle' ('Stichflame' and 'Feuerkerze')—3′ HT, intense rosy-red flowers. 37, 65, 91, 153, 159, 165, 171

'Gypsy Blood' ('Zigeunerblut')—3′ HT, red flowers. 91, 165

'Happy'—1′ HT, deep pink flowers. 37, 63, 95, 153, 159, 165

'Lady Sackville'—3′ HT, purplish-pink flowers. 83

'Pink Spires'—3′ HT, pink flowers. 37

'Purple Spires'—3′ HT, purple flowers. 37, 83, 95, 143, 165, 169

'Red Hybrid'—3′ HT, red flowers. 3

'Robert'—2′ HT, rosy-red flowers. 9, 21, 37, 65, 83, 91, 95, 143, 153, 159, 165, 169, 177

'Roseum Superbum'—3′ HT, rose-purple flowers. 175

'The Beacon'—intense rosy-red flowers. 29, 49, 159

Lythrum virgatum—3′ HT, flower spikes are more slender than *L. salicaria.*

'Dropmore Purple'—3′ HT, purple flowers, 37, 49, 65, 83, 91, 153, 165, 177

'Morden's Gleam'—3′ HT, carmine flowers. 63, 83, 91, 95, 143, 159, 169, 177

'Morden's Pink'—3′ HT, rosy-pink flowers. 9, 21, 27, 37, 49, 65, 77, 83, 91, 95, 122, 137, 153, 159, 165, 169, 171

'Morden's Rose'—3′ HT, rosy-red flowers. 37, 49, 65, 91, 153, 165

'Rose Queen'—rose-pink flowers. 49, 177

'The Rocket'—3′ HT, deep violet-pink flowers. 121

Machaeranthera *tanacetifolia (Aster tanacetifolius)*—2′ HT, violet-blue to white daisies, divided leaves. 123

Machaeranthera tortifolia (Aster tortifolius)—2.5′ HT, blue to lavender to white daisies , lance-shaped, spiny toothed leaves. 173

Macleaya *cordata*—8′ HT, white flowers in summer, large pubescent leaves. 37, 65, 153

Macleaya microcarpa—8′ HT, cream-pink flowers in summer, large rounded lobed gray-green leaves, white tomentose beneath, rhizmatous, but not invasive. 29, 91, 159, 161, 165, 169

'Coral Plume'—rich flesh colored flowers. 29, 65, 83, 95, 153, 165, 171

Malva *alcea*—3.5′ HT, rose-white flowers in summer, soft green fingered leaves, prolific self seeder. 49

'Fastigiata'—upright form. 9, 37, 39, 49, 52, 65, 77, 153, 159, 165, 171, 177

Malva moschata—2-3′ HT, white or pink flowers in summer, finely divided leaves. 3, 9, 52, 69, 107, 121, 159, 165

'Alba'—white flowers. 9, 27, 37, 49, 52, 65, 153, 159, 165

Malva sylvestris—3′ HT, rose-purple flowers in late spring with darker veins, rounded lobed leaves, biennial. 52, 69

Malvaviscus *arboreus*—3′ HT, bright red flowers in summer, shiny mallow blossoms, downy lobed leaves, tender. 41, 181

Manfreda *virginica*—1′ HT, 4′ flower scapes in summer, large succulent leaves. 173

Marshallia *grandiflora*—1′ HT, large pink flowers in early summer, straplike leaves in rosettes. 173

Matelea *carolinensis*—climbing plant to 6′ HT, shiny maroon flowers in late spring. 173

Mazus *japonicus*—1″ HT, small blue flowers in early summer, oval coarsely-toothed leaves, prefers moist organic soil. 133

Mazus reptans—1″ HT, blue flowers in spring with white, yellow and purple spots, good groundcover, prefers moist organic soil. 9, 37, 65, 83, 91, 98, 137, 153, 165, 171

'Alba'—white flowers. 9, 98, 144, 181

Meconopsis cambrica—18″ HT, yellow flowers in spring, fernlike green leaves, biennial or short-lived perennial. 52, 121, 139

'Aurantiaca'—orange flowers. 52

'Gresdan'—orange flowers. 83

Melanthium virginicum—3′ HT, creamy green changing to dark purple flowers in summer, grasslike leaves, requires moist soil. 66

Meum athamanticum—1.5′ HT, white flat-topped clusters in summer, filigreed fragrant leaves. 65, 153

Mimulus bifidus—2.5′ HT, large golden-yellow flowers in summer, oblong, toothed sticky leaves. 54

Mimulus cardinalis—1′ HT, narrow scarlet-yellow flowers in summer, sticky hairy oblong leaves. 52, 61, 145

Mimulus guttatus—18″ HT, brown spotted flowers, oblong leaves. 5, 61

Mimulus lewisii—2.5′ HT, deep rose-pink flowers with a yellow throat, grayish oblong sticky hairy leaves, tolerates dry soil. 5, 145

Mimulus luteus—1′ HT, yellow flowers spotted with red in summer, rounded toothed leaves. 52

'Bonfire'—10″ HT, mixed flowers of yellow, orange and red. 159

'Red Emperor'—2′ HT, blood-red flowers. 159

Mimulus ringens—3′ HT, pale purple-blue flowers in summer, smooth pointed leaves. 120, 173

Monarda citriodora—2′ HT, white to pink flowers spotted with purple in late spring, narrow pubescent leaves, biennial. 183

Monarda didyma—4′ HT, scarlet flowers in summer, downy pointed leaves, invasive, prefers moist to wet soils. 33, 41, 66, 69, 75, 98, 113, 115, 117, 123, 137, 157, 173, 183

'Adam'—bright cerise-red flowers. 29, 37, 61, 65, 83, 91, 95, 133, 143, 153, 159, 169, 171, 173

'Alba'—white flowers. 37

'Beauty of Cobham'—pale pink with purple flowers. 9

'Blue Stocking' ('Blaustrumpf')—violet-purple flowers. 9, 65, 98, 177

'Cambridge Scarlet'—scarlet flowers. 9, 21, 27, 29, 34, 37, 39, 49, 65, 69, 83, 91, 95, 97, 107, 122, 153, 159, 169, 171, 173, 175, 177

'Croftway'—soft pink flowers. 9, 21, 27, 29, 34, 37, 39, 65, 77, 83, 91, 95, 107, 122, 133, 137, 143, 153, 159, 169, 171, 173, 175, 177

'Granite Pink'—rose-pink flowers. 9

'Kardinal'—cardinal-red flowers. 9

'Mahogany'—deep wine-red flowers. 37, 49, 65, 91, 144, 153, 171

'Mrs. Perry'—bright red flowers. 9

'Panorama Hybrids'—mixed flowers of red, rose and pink. 175, 183

'Prairie Brand'—salmon-red. 37

'Prairie Fire'—pure red flowers. 29, 37

'Prairie Night'—deep purple flowers. 9, 29, 37, 77, 83, 173

'Purple Glory'—purple flowers. 95

'Red Select'—red flowers. 3

'Rose Queen'—glowing rose. 95

'Snow Queen'—white flowers. 177

'Snow White'—2.5′ HT, white flowers. 9, 39, 65, 83, 95, 122, 143, 153, 159, 169, 171

'Sunset'—purple-red flowers. 9, 27

'Violet Queen'—rich violet flowers. 29, 37, 65, 91, 115, 122, 153, 171, 173, 175

Monarda fistulosa—3′ HT, lavender-pink flowers, pointed aromatic downy leaves, tolerant of drier soils. 9, 25, 66, 69, 113, 115, 117, 123, 127, 157, 173, 183

'Menthifolia'—97

Monarda punctata—2′ HT, yellow flowers dotted with black, pointed downy aromatic leaves, will grow in sandy to average soils. 69, 77, 113, 115, 117, 127, 157, 173, 175, 183

Monarda russeliana—2′ HT, white to pink flowers spotted with purple, lance-shaped aromatic leaves, will tolerate dry soil. 173

Monardella *odoratissima*—1′ HT, pink and white flowers in summer, lance-shaped hairy aromatic leaves, requires well drained soil. 98

Morina *longifolia*—3′ HT, white flowers turning to clear rose in summer, prickly thistlelike leaves in rosettes, requires well-drained soil, tender. 117, 153, 159

Myosotis *scorpioides*—10″ HT, blue flowers in late spring. 21, 65, 83, 133, 139, 153, 159

'Pinkie'—bright pink flowers. 37, 65, 95, 153

'Sapphire'—brilliant sapphire flowers. 37, 65, 95, 153

'Semperflorens'—rich blue flowers in spring through summer. 27, 159, 171

Myosotis sylvatica—2′ HT, blue flowers in spring, gray leaves, biennial. 5, 83, 133

'Alba'—white flowers. 159

'Indigo'—deeper blue flowers. 159

'Rosea'—pink flowers. 97, 159

'Royal Blue'—compact form. 169

'Victoria'—blue flowers. 33, 52, 75, 97, 175

'Victoria White'—white flowers. 97

Nepeta x *faassenii*—2′ HT, violet-blue spikes in early summer, downy gray aromatic leaves, will rebloom in fall if cut back. 9, 37, 91, 159, 177, 183

'Blue Wonder'—leaves larger than species. 27, 37, 83, 107, 159, 169, 171

'Dropmore Hybrid'—lavender-blue flowers, coarsely toothed gray leaves. 37, 153

'Six Hills Giant'—violet-blue flowers. 34, 91

'Snowflake' ('White Wonder')—white flowers, less vigorous. 9, 37, 65, 153, 159

Nepeta nussinii—1′ HT, shorter version of *Nepeta* x *faassenii*, not as floriferous. 3, 33, 49, 52, 65, 95, 133, 153, 165, 175

Nepeta sibirica—3.5′ HT, violet-blue flowers in summer, green lance-shaped leaves, requires well drained soil. 83

Nierembergia *repens (rivularis)*—2″ HT, white upward-facing flowers with a golden-yellow throat in summer, requires rich moist to damp soil. 52, 54, 65, 98, 145, 153, 171

Oenothera *berlandieri*—10″ HT, cup-shaped rose-pink fragrant flowers in summer, lance-shaped rosettes of leaves, rhizomatous, invasive, requires good drainage. 34, 95

Oenothera caespitosa—4″ HT, large fragrant white flowers opening at night in summer, tufted rosettes of leaves, requires excellent drainage. 144, 173

Oenothera erythrosepala (lamarckiana)—6′ HT, fragrant yellow flowers in summer, changing to orange-red, blooms in the evening, lance-shaped basal rosettes of leaves. 123

Oenothera fruticosa—1.5′ HT, silky wide-cupped brilliant yellow flowers in early summer, dark green pointed leaves turning red in fall, rhizomatous. 52, 63, 83, 113, 157, 177

Oenothera missourensis—10″ HT, large deep yellow flowers in summer, dark green leaves with silver midribs on trailing stems, requires well drained soil. 21, 33, 37, 61, 63, 65, 67, 75, 77, 83, 97, 109, 133, 139, 143, 153, 159, 165, 169, 177

Oenothera odorata—3′ HT, fragrant wide pale yellow flowers in summer fading to coral, blooms in the evening, stems and buds tufted red, basal rosettes of narrow crinkled leaves, large pointed seed pods. 52, 159

Oenothera perennis—2′ HT, yellow drooping flowers in early summer, narrow leaves. 9

Oenothera speciosa—2′ HT, pink flowers in summer, narrow tapering leaves, invasive. 9, 27, 37, 49, 117, 121, 123, 144, 181

'Rosea'—rose-pink flowers. 159, 171

Oenothera tetragona (fruticosa 'Youngii')—1.5′ HT, bright yellow flowers in early summer, red buds and stems, red fall color. 21, 33, 37, 52, 61, 65, 97, 107, 113, 115, 123, 153, 157, 159, 181

'Fireworks' ('Fyrverkeri')—purple-green leaves. 3, 9, 37, 39, 49, 65, 83, 95, 107, 153, 159

'Highlight'—green buds instead of red, larger yellow flowers. 29, 37, 65, 153, 159

'Yellow River'—large yellow flowers. 9, 159

Onopordum *nervosum*—8′ HT, rose-purple flowers in summer, white woolly long spiny leaves, biennial or short-lived perennial. 83

Onosma *alboroseum*—8″ HT, tubular white nodding flowers aging to pink in summer, narrow thick hairy tufts of gray-green leaves, requires excellent drainage, sandy soil and protection from winter moisture. 145

Onosma nanum—8″ HT, hanging tubular creamy yellow flowers changing to blue in summer, blue-gray hairy tufts of leaves, requires excellent drainage, sandy soil and protection from winter moisture. 145

Onosma tauricum—10″ HT, hanging large pendent gold flowers, deep green bristly leaves. 145

Opuntia: are cacti with succulent rounded spiny pads (joints) with a trailing habit, they require well drained sandy soil and bloom in late spring to early summer.

Opuntia 'Arkansas Yellow'—6″ HT, bright yellow flowers. 133

Opuntia basilaris—4′ HT, cerise-to-rose flowers, joints long oval and light blue, spineless.

aurea—pink or yellow flowers. 87

basilaris—pink flowers. 87

woodburyi—144

Opuntia 'Desert Splendor'—6″ HT, large pink to purple flowers. 133, 144

Opuntia erinacea—1.5′ HT, white to yellow or red flowers, oblong joints.

erinacea—yellow flowers, joints densely spined. 87

ursina—pink flowers, joints most heavily spined. 87

utahensis—pink or red flowers, joints with long white spines. 87

Opuntia humifusa—1′ HT, large yellow flowers, joints broad rounded nearly spineless, red fruit. 65, 67, 87, 91, 120, 144, 153, 173

'Lemon Form'—bright lemon-yellow flowers. 159

'Orange Form'—yellow flowers with orange centers. 159

Opuntia imbricata—small purple flowers, very spiny cylindrical joints. 173

'Davisii'—144

Opuntia littoralis martiniana—5′ HT, yellow flowers, large oval green joints, red fruits. 87

Opuntia macrorhiza—yellow flowers, oval bright green leaves. 87

Opuntia phaeacantha—5′ HT, salmon or yellow flowers, large oval joints. 11, 87

'Discata'—144

Opuntia polyacantha—6″ HT, yellow tinged red flowers, small rounded joints. 87

juniperiana—yellow flowers, large joints. 87

rufispina (rutila)—pink flowers, long fingerlike joints. 87, 144

Opuntia 'Smithwich'—6″ HT, large yellow flowers, small pads. 11, 133, 144

Opuntia whipplei—3′ HT, chartreuse flowers, long cylindrical joints. 87

Origanum microphyllum—8″ HT, small pink spikes in summer, small gray leaves on purple stems. 95, 98, 145

Orostachys aggregata—4″ HT, pink spines in late summer to fall, light green succulent leaves, trailing rosettes of leaves. 54, 121, 133

Orostachys erubescens—3″ HT, white and pink flowers, fringed rosettes of leaves. 37, 133

Orostachys furusei (iwarenge)—3″ HT, pink spires, blue rosettes of leaves. 37, 54, 109, 133, 137

Orostachys spinosa—overlapping rosettes of leaves each with a spiny tip. 3, 37, 133

Osteospermum 'Starshine'—1′ HT, pink, rose and white flowers with a yellow center in summer, narrow light green leaves, requires excellent drainage, tender. 175

Oxypetalum caeruleum—3′ HT, pale blue flowers, oblong lance-shaped slightly downy leaves. 181

Oxytropis lambertii—8″ HT, purple pealike flowers in summer, pealike silky gray leaves, requires excellent drainage. 97

Paeonia collection of named hybrids—4′ HT, single and double flowers in late spring, deep green divided leaves, new foliage is reddish, requires good moist organic soil. 9, 21, 27, 29, 37, 39, 45, 63, 83, 97, 107, 122, 153, 159, 169, 171, 175

Papaver alpinum—10″ HT, white, yellow, red, orange or pink flowers in summer, silver-gray leaves, requires excellent drainage. 97, 133

Papaver atlanticum—2′ HT, orange-red or scarlet flowers in summer, hairy toothed and lobed leaves. 3

'Plena'—double flowers. 49

Papaver nudicaule (miyabeanum)—1′ HT, white, yellow, orange or pink fragrant flowers, lobed glaucous leaves in rosettes. 5, 33, 37, 97

'Garden Gnome'—1′ HT, large yellow, orange, pink or white flowers, compact habit. 37

'Illumination'—1.5′ HT, pastel mix. 3, 52

Papaver orientale collection of named hybrids—3′ HT, various flowers of orange, pink, and red, hairy divided gray-green leaves appearing in late summer and fall. 3, 9, 21, 25, 27, 33, 37, 39, 49, 65, 75, 83, 95, 97, 107, 137, 153, 159, 161, 169, 171, 175, 183

Papaver pilosum—3′ HT, pale scarlet to bright orange flowers in early summer. 49

Papaver spicatum—2.5′ HT, orange-red flower spikes in summer, downy oblong leaves with serrated edges. 161

Papaver orientale

Parnassia asarifolia—1′ HT, white flowers with green veins in late summer, basal heart-shaped leaves. 173

Parnassia glauca 'Bruce Peninsula'—1′ HT, white upward-facing cup-shaped flowers in late summer, prefers swampy soils. 11

Parnassia palustris—1′ HT, white flowers with green veins in late summer. 120

Paronychia kapela serpyllifolia—prostrate groundcover, silvery white papery bracts in summer, gray-green leaves. 133, 145

Patrinia heterophylla—3′ HT, clusters of small bright yellow flowers in late summer, finely divided leaves, requires moist soil. 173

Patrinia intermedia 'Altais'—11

Patrinia scabiosifolia—6′ HT, bright yellow airy panicles in summer, finely divided leaves. 49, 173

Patrinia triloba—2′ HT, golden-yellow flower clusters in summer, lobed and toothed leaves. 159

Patrinia villosa—3′ HT, small white panicle in late summer, coarse divided. 173

Pediocactus simpsonii—6″ HT, pink flowers in spring, very spiny. 87

Peltiphyllum peltatum—4′ HT, white to pink flowers in spring, large rounded leaves on single stems, rhizomatous, invasive, requires moist to wet soil. 9, 21, 91, 159, 171

Penstemon: require excellent drainage, but will not tolerate winter moisture, unless noted, each species produces snapdragonlike blooms on spikes.

Penstemon australis—2′ HT, pink to lavender flowers in late spring, oblong lance-shaped leaves. 113, 115, 117, 173

Penstemon barbatus—4′ HT, bright scarlet flowers with a pink throat in summer, narrow glossy evergreen leaves. 3, 97, 121

'Alba'—3′ HT, white flowers. 39, 49, 61, 65, 153

'Alba Nana'—1.5′ HT, white flowers. 137

'Coccineus'—1.5′ HT, scarlet flowers. 159, 161

'Elfen Pink'—1′ HT, clear pink flowers. 29, 37, 39, 49, 137, 159, 169, 183

'Praecox'—1.5′ HT, mixed flowers of pink and red. 65, 107, 159, 161

'Prairie Dawn'—1.5′ HT, deep rose-pink flowers. 37, 137, 159

'Prairie Dusk'—1.5′ HT, rosy-purple flowers. 39, 83, 107, 145

'Prairie Fire'—2′ HT, scarlet flowers. 29, 37, 39, 65, 95, 137, 153, 169, 177

'Rose Elf'—1.5′ HT, deep rose flowers in summer. 37, 65, 95, 133, 153, 159, 177

'Torey'—1.5′ HT, flame-red larger flowers. 37, 137

Penstemon barrettiae—1′ HT, large lilac-purple flowers, thick leathery lance-shaped leaves. 95

Penstemon 'Blue Midnight'—deep blue flowers. 61

Penstemon 'Brightenbush Blue'—6″ HT, deep lavender-blue flowers in late spring, evergreen oblong to rounded leaves. 145

Penstemon caespitosus 'Claude Barr'—2″ HT, creeping habit, lilac flowers in early summer, small thymelike leaves. 11

Penstemon canescens—2′ HT, purple flowers outside with white inside and purple stripes in late spring, rounded leaves. 115, 173

Penstemon cardwellii—18″ HT, large purple flowers in summer, dark green finely toothed leaves. 121

'Floyd McMullen'—6″ HT, large wine-purple flowers, dark green finely toothed leaves. 145

'Roseus'—6″ HT, rose flowers. 145

Penstemon cobaea—2′ HT, large lavender flowers in summer, oblong leaves. 52

Penstemon crandallii procumbens—8″ HT, dark blue flowers in summer, small evergreen leaves. 145

Penstemon 'Crystal'—14″ HT, white flowers in late spring, lance-shaped shiny green leaves. 9

Penstemon cyananthus—3′ HT, bright blue flowers in summer, thick glaucous lance-shaped leaves. 121

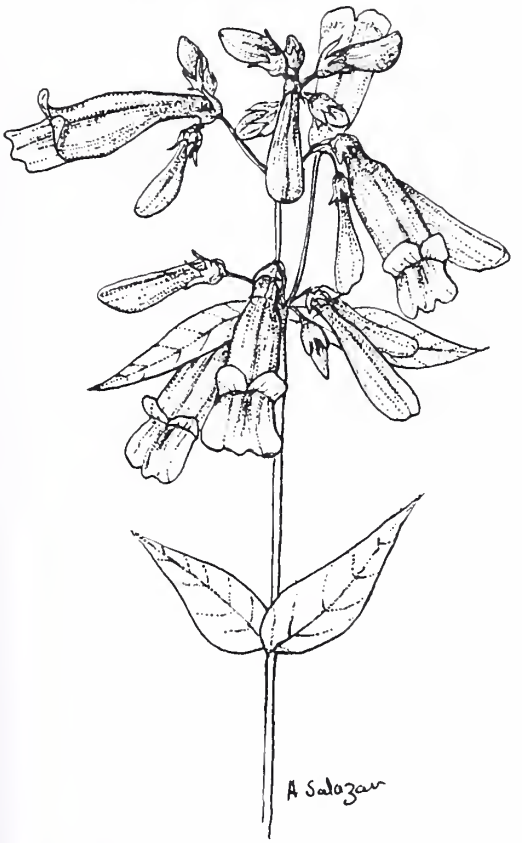
Penstemon davidsonii—4″ HT, lavender to purple flowers in early summer, evergreen round leaves forming mats, tender. 145

'Broken Top Mt.'—rich purple flowers. 145

menziesii—6″ HT, leathery leaves, blooms in spring. 95

microphyllus—5″ HT, very small leaves, good for trough garden. 133

Penstemon discolor—8″ HT, white flowers outside flushed with red and yellow inside in summer, small linear leaves. 145



Penstemon canescens

Penstemon dissectus—1.5′ HT, lavender and yellow flowers in summer, dissected leaf. 181

Penstemon fruticosus—3′ HT, purple and yellow flowers in summer, small lance-shaped leathery leaves. 95

'Holly'—10″ HT, light lilac-purple flowers in late spring, leaves resemble holly, requires good drainage. 49, 133

serratus—10″ HT, lilac-purple flowers, toothed leaves. 121

Penstemon gentianoides—4.5′ HT, bluish-purple flowers in summer, lance-shaped leaves, tender. 83

Penstemon gracilis—16″ HT, lilac to white flowers in summer, linear lance-shaped leaves. 127

Penstemon grandiflorus—4″ HT, lavender flowers in early summer, glaucous leathery leaves. 97, 117, 127

Penstemon heterophyllus—2′ HT, blue to purple flowers in summer, linear shiny leaves, tender.

'Blue Spring'—10″ HT, blue flowers. 3, 9, 65, 153, 159

Penstemon hirsutus—3′ HT, pink flowers in early summer, evergreen lance-shaped hairy leaves. 25, 49, 161

'Pygmaeus'—6″ HT, dwarf form. 3, 37, 52, 61, 121, 137, 145, 173, 183

Penstemon 'Husker Red'—2′ HT, light pink flowers in summer, maroon lance-shaped leaves. 37

Penstemon knuthii—3

Penstemon laevigatus—2.5′ HT, white flowers in dense clusters, evergreen lance-shaped leaves with reddish fall color. 123, 173

Penstemon 'Mesa'—1.5′ HT, deep lavender-blue flowers, narrow deep green leaves. 37

Penstemon newberryi—6″ HT, reddish-purple flowers in early summer, small rounded leathery toothed leaves forming evergreen mats. 5, 61, 95, 145

Penstemon ovatus—3′ HT, blue flowers in summer, oval leaves, reddish fall color, biennial. 121

Penstemon pinifolius—10″ HT, coral-red flowers in summer, needlelike evergreen leaves. 3, 9, 29, 37, 49, 83, 97, 107, 133, 144, 145, 153, 169, 183

Penstemon rupicola—8″ HT, rose-crimson flowers in summer, blue-gray oval toothed leaves, requires good drainage, tender. 95

'Diamond Lake'—rich pink flowers, more vigorous. 145

'Pink Dust'—5″ HT, large soft pink flowers, bluish dense rounded leaves. 145

'Pink Holly'—6″ HT, bright pink flowers, hollylike leaves. 145

Penstemon smallii—3′ HT, light lavender-pink flowers, lance-shaped leaves, reddish fall color. 54, 95, 113, 117, 123, 157, 173

Penstemon strictus—2′ HT, deep blue flowers, lance-shaped leaves, reddish fall color. 5, 97, 121, 175

Penstemon virens—8″ HT, bright blue-gold flowers in early summer, evergreen lance-shaped leaves. 11, 97

Penstemon 'Wax Works'—8″ HT, bright lavender-purple flowers in summer, waxy leaves. 145

Penstemon whippleanus—15″ HT, dark purple to burgundy flowers in summer, thin lance-shaped leaves, requires excellent drainage. 97

Perovskia atriplicifolia—4′ HT, lavender-blue spikes in late summer, gray-green small finely cut aromatic leaves, white beneath. 9, 21, 27, 37, 39, 61, 65, 77, 83, 91, 107, 109, 144, 153, 159, 165, 177

Petalostemon candidum—1.5′ HT, white pealike flowers in summer, pealike narrow leaflets, requires good drainage. 107

Petalstemon purpureum—3′ HT, purple-crimson pealike flowers in summer, pealike narrow leaflets, requires good drainage. 107, 127, 173

Petasites japonicus—5′ HT, whitish-purple fragrant flower spikes in spring, leaves to 2 feet across, stalks and flower buds are edible, rhizomatous, invasive, requires moist to wet soils. 'Gigantea'—leaves to 3 feet across. 69, 83

Petrorhagia saxifraga (Tunica saxifraga)—10″ HT, pink flowers in late summer, short needlelike gray-green leaves, requires good drainage. 49, 52, 159

'Alba Plena'—double white flowers. 34

'Flore Plena'—double pink flowers. 49, 137, 144

'Rosea'—rose-pink flowers. 83, 95, 153

'Rosette'—rose flowers. 159

'Rosea Flore Plena'—double rose-pink flowers. 34, 37, 65, 177

Phlomis fruticosa—4′ HT, intense yellow flowers in whorls in summer, downy oval lance-shaped leaves, requires good drainage, tender. 139

Phlomis samia—3′ HT, purple flowers in whorls in summer, coarse dark green leaves, tender. 91

Phlomis tuberosa—6′ HT, purple and pink flowers in whorls, oval to heart-shaped coarse green leaves. 144

Phlox 'Alborado'—6″ HT, orange flowers streaked with yellow in summer, requires well drained soil and must be kept dry in winter. 145

Phlox alyssifolia—6″ HT, purple and pink flowers in early spring, linear to stiff evergreen leaves, requires good drainage and will tolerate winter moisture. 11

Phlox amoena—10″ HT, dense clusters of salmon-pink flowers in spring, evergreen lance-shaped leaves turning red in winter, requires excellent drainage. 49, 95, 109, 133, 173

'Pinstripe'—pink petals with a thin white stripe. 173

'Snowdrift'—smaller pure white flowers, light green leaves, no fall color. 173

'Vein Mountain'—deep rose flowers shading to maroon, good wine-red fall color. 173

Phlox andicola—5″ HT, white flowers in spring, thin awl-shaped leaves. 11

Phlox bifida—10″ HT, notched lavender-blue flowers in late spring, awl-shaped leaves, requires well-drained soil. 121, 145

'Alba'—white flowers. 54

'Colvin's White'—pure white flowers. 11, 49, 133, 145, 181

'Starbright'—lilac-blue flowers with lighter margins. 54, 137

Phlox borealis—4″ HT, lilac, lavender and white flowers in spring, needlelike leaves, requires good drainage. 33, 133

Phlox carolina—3′ HT, white to purple fragrant flowers in late spring, tapering shiny leathery leaves, more mildew resistant than *P. paniculata*. 113, 173

'Eco Pinks'—bright pink flowers. 54

'Miss Lingard'—white flowers with a yellow center. 9, 21, 29, 34, 37, 39, 49, 52, 54, 65, 77, 95, 107, 153, 159, 165, 169, 171, 173, 175, 177

'Rein du Jour'—37, 49, 173

'Rosalinde'—deep rose-pink flowers. 29, 37, 39, 49, 65, 95, 107, 153, 165, 173, 177

Phlox 'Dolni Pena'—3″ HT, lilac flowers, evergreen tufted neeedlelike leaves. 133

Phlox douglasii—6″ HT, various flowers in spring, green needlelike leaves, evergreen, compact habit.

'Beauty of Ronsdorf'—3″ HT, pink flowers. 145

'Crackerjack'—3″ HT, bright crimson-red flowers. 133, 145

'Daniel's Cushion'—deep pink flowers. 133, 145

'Red Admiral'—ruby-red flowers. 145

'Red Wings'—4″ HT, bright red flowers. 137

'Snow White'—4″ HT, white flowers. 91

'Unique'—11

Phlox 'Ellie B.'—4″ HT, notched white flowers in spring, evergreen needlelike leaves. 54

Phlox 'Encore'—5″ HT, light pink flowers with notched petals and a darker center in spring and fall, needlelike compact leaves. 133

Phlox glaberrima—3′ HT, pink to purple flowers in late spring, lance-shaped shiny leaves. 137

triflora—flowers larger than species. 49, 173, 181

Phlox 'Laura'—4″ HT, pastel pink flowers with rounded petals in spring, needlelike leaves. 133, 145

Phlox maculata—4′ HT, pink and purple flowers in early summer, shiny lance-shaped dark green leaves, stems spotted dark red. 66

'Alpha'—bright rose flowers. 9, 29, 34, 37, 77, 107, 159, 171

'Delta'—lilac flowers. 29

'Omega'—white flowers with a lilac eye. 9, 29, 37, 65, 77, 107, 153, 159, 171, 177

Phlox mesolenca—6″ HT, blooms in early summer, linear pubescent leaves, requires good drainage and dry winter conditions.

'Arroyo'—glowing carmine-rose flowers. 145

'Manzana'—clear pink flowers with overlapping petals. 145

'Mary Maslin'—vermilion flowers with a yellow center. 145

'Paul Maslin'—butter-yellow flowers with a deep maroon center. 145

'Tangelo'—glowing orange flowers. 145

'Vanilla'—cream flowers. 145

Phlox 'Millstream Jupiter'—6″ HT, lavender-blue flowers with a dark center in spring, needlelike leaves. 37, 54, 77, 83, 137, 145, 153

Phlox nivalis—6″ HT, pink to purple flowers with a darker eye in spring, semievergreen needlelike leaves on trailing stems. 173

'Camla'—large salmon-pink flowers with a deep pink center. 145

'Dixie Brilliant'—clear pink flowers with a dark red center. 137

'Eco Flirtie Eyes'—large pastel flowers with a wine-red center in a white ring. 54

Phlox ovata—1′ HT, large purple flowers in late spring, requires moist organic soil. 54, 95, 137, 159, 173

'Spring Delight'—lavender-pink flowers. 181

Phlox 'O.G.K.'—3″ HT, bright pink flowers in spring, dark green narrow semievergreen leaves. 109

Phlox paniculata (decussata)—4′ HT, lilac to purple fragrant flowers in summer, lance-shaped leaves, requires moist organic soil. 169, 173

'Adonis'—reddish-purple flowers. 159

'Aida'—2′ HT, dark carmine-red flowers with a purple center. 3, 83

'Amethyst'—light blue flowers. 83

'Barnwell'—2.5′ HT, rose-pink flowers. 159

'Blue Boy'—dark lavender flowers. 3, 21, 29, 37, 49, 65, 83, 133, 153, 159, 169, 175

'Blue Ice'—white flowers with a lavender center. 159, 177

'Blue Lagoon'—3′ HT, lavender-blue flowers. 159, 177

'Border Gem'—3′ HT, purple flowers. 83

'Bouvardier'—fuchsia-purple flowers. 37, 159

'Brigadier'—3′ HT, orange-red flowers. 21, 65, 153

'Bright Eyes'—2′ HT, soft pink flowers with a deep red center. 37, 49, 133, 159, 169, 175, 177

'Bridesmaid'—3′ HT, white flowers with a crimson eye. 83

'Caroline Vandenburg'—3′ HT, rich lavender-blue flowers. 37, 159

Phlox maculata

'Charles Curtis'—2.5′ HT, brilliant sunset-red flowers. 65, 153

'Charmine'—3′ HT, bright cherry-red flowers. 177

'Cecil Hanbury'—3′ HT, salmon-red flowers. 83

'Coral Eye'—6″ HT, white flowers blushed with pink and a coral center. 133, 145

'Dodo Hanbury Forbes'—3′ HT, clear pink flowers. 27, 29, 37, 45, 49, 65, 77, 83, 95, 107, 133, 153, 159, 169

'Dramatic'—3′ HT, salmon-pink flowers. 177

'Dresden China'—4′ HT, shell-pink flowers with a deep pink eye. 37, 65, 83, 153, 159, 177

'Eclaireur'—3′ HT, purple flowers with a white eye. 83

'Eco Dayglow'—3′ HT, glowing dark pink flowers darkening toward the center. 54

'Elizabeth Arden'—3′ HT, soft pink flowers. 37, 65, 83, 153

'Europa'—2.5′ HT, white flowers with a carmine eye. 83

'Eva Foerster'—3

'Everest'—3.5′ HT, white flowers with a rose eye. 159, 177

'Fairest One'—3′ HT, pale salmon-pink flowers with a red center. 9, 29, 37, 159, 169

'Fairy's Petticoat'—3.5′ HT, light pink flowers with a dark pink eye. 29, 37, 159, 169, 171, 177

'Fall Days'—3′ HT, dark rose flowers in late summer. 159, 177

'Franz Schubert'—3′ HT, lilac-blue flowers with a crimson eye. 159, 171

'Fuchsia'—3′ HT, purple flowers. 37, 169

'Gaiety'—3.5′ HT, brilliant salmon flowers with a cherry red eye. 159, 177

'Juliet'—2′ HT, pale pink flowers. 65, 153

'July Glow'—2.5′ HT, dark carmine-red flowers. 83

'Kirmslandler'—3′ HT, white flowers with a red eye. 3, 21, 83

'Kirchenfurst'—2.5′ HT, carmine-red flowers. 83

'Leo Schlagater'—3′ HT, dark red flowers. 29, 95, 169

'Lavendelwolke'—3′ HT, lilac flowers. 83

'Lilac Time'—purple flowers. 37, 49, 137, 153, 169

'Mary Louise'—white flowers. 159

'May Snow'—white flowers. 83, 133

'Mia Roys'—1.5′ HT, pure white flowers. 9, 29, 83

'Mies Copyn'—3′ HT, pink flowers. 83

'Mount Fujiyama'—3.5′ HT, white flowers. 9, 29, 37, 49, 65, 77, 95, 133, 153, 157, 169, 171, 173, 175

'Mrs. R.P. Struthers'—3′ HT, carmine-red flowers, bronze leaves. 159, 171

'Orange'—3′ HT, salmon-orange flowers with a lighter eye. 9, 65, 153

'Orange Perfection'—2′ HT, bright orange-salmon flowers. 21, 29, 37, 49, 83, 107, 153, 159, 169, 171, 175, 177

'Pinafore Pink'—1.5′ HT, clear bright pink flowers. 9, 37, 153, 159, 169, 171, 175

'Pink Gown'—2.5′ HT, deep pink flowers. 37, 49

'Prime Minister'—3.5′ HT, white flowers with a red eye. 9, 29, 37, 49, 65, 77, 83, 95, 107, 153, 159, 169, 171

'Prince of Orange'—2.5′ HT, brilliant orange flowers. 95

'Princess'—3′ HT, white flowers. 27

'Rembrandt'—3′ HT, white flowers. 83

'Progress' -3′ HT, light blue flowers with a

dark purple eye. 9, 27, 37, 83, 153, 159, 171, 173

'Russian'—3′ HT, rich violet-purple flowers. 37, 159

'Royal Purple'—3′ HT, dark violet-blue flowers. 153, 159

'Rynstroom'—3.5′ HT, rose-pink flowers. 21, 83

'Salmon Beauty'—3′ HT, bright salmon-pink flowers. 65, 107

'Salmon Glow'—2.5′ HT, bright salmon-pink flowers. 37, 153

'Sandra'—1.5′ HT, scarlet flowers. 9, 37, 65, 153, 159, 169, 171, 175

'Sir Malcolm Campbell'—3′ HT, orange flowers. 83

'Sir John Falstaff'—2.5′ HT, salmon-pink flowers. 9, 29, 37, 159

'Snowstorm'—3′ HT, pure white flowers. 65

'Spitfire'—3′ HT, deep red flowers. 9

'Starfire'—3′ HT, brilliant red flowers. 3, 9, 21, 27, 29, 37, 49, 65, 77, 83, 95, 107, 133, 153, 157, 159, 169, 171

'Starlight'—3′ HT, violet flowers with a white eye. 29

'Sweetheart'—2.5′ HT, pink flowers. 83

'Symons-Jeune'—3′ HT, rose-pink flowers with a vermilion eye. 3, 37, 45, 159, 169, 171

'Tenor'—3′ HT, red flowers. 21, 83, 159, 169, 171

'The King'—2.5′ HT, deep violet-purple flowers. 9, 29, 83, 133, 153, 169, 171

'Thunderbolt'—2.5′ HT, bright scarlet flowers. 37

'Thundercloud'—3′ HT, red flowers. 65, 153

'Vintage Wine'—2′ HT, purple-red flowers. 83

'White Admiral'—3′ HT, pure white flowers. 9, 21, 37, 45, 65, 83, 153, 159, 171, 177

'William Ramsey'—2′ HT, purple flowers. 83

'Windsor'—3.5′ HT, pale rose flowers with a salmon eye. 21, 65, 95, 153, 159

'World Peace'—3.5′ HT, pure white flowers. 37, 65, 107, 153, 159, 177

'Variegata'—leaves edged with cream. 37

Phlox x 'Pink Stars'—6″ HT, light pink star-shaped flowers in spring, needlelike leaves. 37, 133

Phlox pilosa—1.5′ HT, purple to pink to white flowers in late spring, deep green narrow leaves, rhizomatous, somewhat invasive. 66, 109, 115

ozarkana—leaves wider than species. 159

Phlox x *procumbens*—1′ HT, purple flowers in spring, oblong lance-shaped leaves. 49, 109, 145, 159, 173

'Millstream Daphne'—intense pink flowers. 11, 37, 95, 121, 144, 171

'Millstream Pink'—clear pink flowers. 54

'Variegata'—pink flowers, white leaf margins. 54, 159

Phlox pulchra—1′ HT, pastel pink fragrant flowers, requires moist organic soils. 11, 54, 173

Phlox 'Rose Queen'—5″ HT, pale silvery-pink flowers, compact needlelike leaves. 133

Phlox 'Scarlet Flame'—6″ HT, red flowers in spring, needlelike evergreen leaves. 133

Phlox 'Sigrid'—6″ HT, soft pink flowers with notched petals in spring, needlelike evergreen leaves. 133

Phlox subulata—6″ HT, purple to pink to white flowers in spring, awl-shaped leaves in evergreen mats, requires well drained soil. 3, 5, 33, 63, 66

'Alexander's Pink'—pink flowers with a red eye. 95, 137

'Alexander's Surprise'—pink flowers. 65, 153

'Alexander's Wild Rose'—deep rose-pink flowers in spring and fall. 37, 65, 133, 153

'Apple Blossom'—soft pink flowers. 9

'Atropurpurea'—rich wine-red flowers. 37, 83, 97, 137, 153, 169

'Australis'—4″ HT, fragrant pink to purple flowers, reblooms in fall. 137

'Blue Hills'—rosy-blue flowers. 37, 95, 145, 171

'Bluets'—small sky-blue flowers with a deep violet eye. 37, 137

'Blue Velvet'—deep blue flowers. 37

'Brilliant'—deep red flowers. 37, 65, 83, 95, 153

brittonii 'Rosea'—deeply notched rose colored petals. 3, 145

'Chalky'—white flowers. 137

'Coral Eye'—soft pink flowers with a red-coral eye. 9, 27, 54, 77, 121

'Crimson Beauty'—rosy-red flowers. 3, 9, 137, 169

'Cynthiana'—red flowers with darker red eye. 137

'Daniel's Cushion'—large deep pink flowers. 37

'Eco Mini Purple'—4″ HT, purple flowers with a darker eye. 54

'Elsie B.'—pure white flowers. 37

'Emerald Blue'—blue flowers. 9, 37, 65, 83, 97, 107, 137, 153, 159, 169, 177

'Emerald Pink'—pink flowers on compact growth. 37, 65, 83, 97, 107, 122, 137, 153, 159, 169

'Exquisite'—orchid-pink flowers. 83, 95, 153

'Ft. Hill'—deep pink flowers with deeply cleft petals. 137

'Ice Mountain'—white flowers. 11

'Intensity'—intense rose-red flowers. 83, 95, 153

'Laura'—clear pastel pink flowers. 54, 121

'Maiden Blush'—white flowers with a red eye, reblooms in fall. 137

'Pink Surprise'—pink flowers. 177

'Profusion'—white flowers with a red eye. 9, 37, 83, 153

'Red Wings'—rose-red flowers with a scarlet eye. 9, 37, 65, 83, 95, 153, 169, 177

'Rosea'—rose-pink flowers. 3, 83, 133, 145, 169

'Scarlet Flame'—bright scarlet flowers. 37, 65, 77, 83, 95, 107, 153, 159, 169, 171

'Sneewichten'—3″ HT, snow white flowers, dwarf form. 133, 145

'Star of Heaven'—3″ HT, pink flowers with a dark pink eye. 121

'Sunnydale'—red flowers. 83

'Tamanongalei'—white flowers with a pink stripe down each petal. 145

'Twin Creek'—soft rose pink flowers. 121

'Unique'—rose flowers. 3, 133

'White Cascade'—white flowers. 11

'White Cushion'—pure white flowers. 95

'White Delight'—large pure white flowers. 3, 9, 37, 65, 83, 107, 117, 137, 153, 159, 169, 177

'White Emerald'—white flowers. 97

Phoenicaulis cheiranthoides (Parrya menziesii)—6″ HT, pink to purple flowers in summer, gray oblong lance-shaped leaves, requires good drainage and dry summer conditions. 133

Phormium tenax—5′ HT, red flowers, basal leaves 9 feet long with red margins, tender. 69

Phygelius aequalis—3′ HT, slender trumpet flowers of coral to red with a yellow throat in summer, toothed oval lance-shaped dark green leaves. 95

'Yellow Trumpet'—3′ HT, creamy yellow flowers, light green leaves. 34, 109

Phygelius capensis—4′ HT, bright red flowers with a yellow throat in summer. 52, 95

Physalis alkekengi (franchettii)—2′ HT, small white flowers in spring, oval leaves, orange inflated husk in fall, rhizomatous, invasive. 61, 69, 83, 95, 107, 153, 159, 165, 169

'Gigantea'—larger fruit. 161

'Pygmaea' ('Gnom')—8″ HT, dwarf form. 3, 153

Physostegia virginiana (Dracocephalum virginianum)—3′ HT, pink to purple flowers in late summer, arrow-shaped toothed shiny green leaves, rhizomatous, invasive, requires moist to wet soils. 3, 33, 113, 115, 157, 165, 173, 183

'Alba'—white flowers. 61, 77, 165, 177

'Bouquet Rose'—rose-pink flowers, reddish stems. 29, 37, 65, 153, 165, 177

'Crown of Snow'—white flowers. 97

'Pink Bouquet'—rose-pink flowers. 49, 97, 169

'Rosea'—rose flowers. 159

'Rosy Spire'—rose-pink flowers. 83

'Summer Snow'—white flowers earlier than species. 9, 21, 27, 29, 37, 49, 65, 83, 91, 95, 153, 159, 165, 169, 171, 175

'Summer Spire'—pink flowers. 29

'Variegata'—pink flowers, leaves edged with white. 49, 153

'Vivid'—bright orchid-pink flowers. 9, 21, 27, 29, 37, 39, 49, 65, 77, 91, 95, 153, 159, 165, 171, 175, 183

Phyteuma scheuchzeri—1′ HT, light blue flowers on pointed tubular cluster in summer, oval lance-shaped leaves, requires well drained coarse soil. 161

Phyteuma sieberi—6″ HT, deep blue flowers in summer similar to *P. scheuchzeri*. 61

Phytolacca americana—8′ HT, drooping white panicles of flowers in summer, large oblong leaves, dark maroon fruits in fall, red stems, self seeds, invasive. 69, 83

Pityopsis graminifolia (Chrysopsis and *Heterotheca graminifolia)*—2′ HT, bright yellow asterlike flowers in late summer, grassy, silky hairy leaves. 113, 173, 181

Platycodon grandiflorus—3′ HT, blue flowers in summer, balloonlike flower buds, narrow blue-green leaves. 21, 33, 37, 49, 61, 63, 75, 139, 157, 165

'Albus'—2′ HT, white flowers. 21, 27, 37, 65, 83, 107, 143, 153, 159, 161, 165, 169, 177

'Apoyama'—6″ HT, violet-blue flowers. 3, 37, 65, 77, 95, 143, 159, 161

'Blue'—2′ HT, violet-blue flowers. 107, 137, 165, 169, 171

'Double Blue' ('Flore Pleno')—2′ HT, double blue flowers with dark veins. 29, 37, 49, 65, 95, 122, 143, 153, 159, 169, 171

'Fuji Blue'—2′ HT, blue flowers. 175

'Fuji Pink'—2′ HT, soft pink flowers. 49, 175

'Fuji White'—2.5′ HT, white flowers. 49, 175

'Hime Muraski'—1′ HT, large violet-blue flowers. 159

'Komachi'—10″ HT, deep violet-blue flowers. 33, 117, 143, 175

'Mariesii'—1′ HT, rich blue flowers. 9, 21, 27, 29, 37, 65, 77, 83, 97, 107, 139, 143, 153, 159, 161, 165, 169

'Mariesii Alba'—1′ HT, white flowers. 9

'Mother of Pearl'—2′ HT, bright pink flowers. 161

'Nova Nana'—10″ HT, violet-blue flowers. 137

'Pink'—2′ HT, large pink flowers. 137

'Shell Pink Flowers'—2′ HT, pastel pink

flowers. 21, 37, 65, 107, 143, 153, 159, 165, 169, 177

Polemonium caeruleum—15″ HT, blue cup-shaped flowers in late spring, finely divided leaves, prefer moist organic soil. 3, 21, 33, 37, 49, 52, 61, 83, 107, 113, 137, 143, 159, 169

'Album'—white flowers. 52

'Blue Pearl'—rich lavender-blue flowers. 9, 37, 49, 65, 83, 95, 153, 159

Polemonium foliosissimum—3′ HT, violet-lilac bell-shaped flowers with orange stamens in early summer, finely divided leaves, prefers moist organic soil. 37

Polemonium pauciflorum—1′ HT, yellow flowers tinged with red in summer, finely divided leaves, prefers moist organic soil, tender. 161

Polemonium pulcherrimum—1′ HT, violet-blue flowers in spring, finely divided leaves, prefers moist organic soil. 3, 9, 143, 173

Polemonium reptans—1′ HT, blue flowers in spring, finely divided leaves, trailing habit, rhizomatous, prefers moist to wet soils. 9, 11, 21, 25, 37, 49, 54, 66, 115, 120, 123, 133, 139, 157, 161, 173

'Album'—white flowers. 139

Polygonum affine—9″ HT, bright rose flowers in fall, thin dark green leaves turning red in fall, invasive, requires moist to wet soils. 49, 95

'Darjeeling Red'—deep pink flowers aging to rich red. 34, 61, 83, 107

'Dimity'—rosy-pink flowers. 34

'Pink Jewel'—pink flowers. 83

Polygonum amplexicaule 'Atrosanguineum'—3′ HT, rich crimson flower spikes in late summer, coarse dark green leaves. 34

Polygonum bistorta 'Superbum'—2′ HT, pink flower spikes in early summer, coarse dark green leaves, requires moist to wet soil. 34, 49

Polygonum capitatum—3″ HT, pink flowers in dense heads in spring, dark green leaves with a dark "v" in the center, invasive, good groundcover, tender. 91, 98

'Border Jewel'—bright rose-pink flowers. 37, 65, 153, 159, 165, 169

Polygonum cuspidatum (Reynoutria japonica)—8′ HT, white flowers in late summer, oval heart-shaped leaves, red fall color, rhizomatous, invasive. 144

compactum—3′ HT, white flowers turning deep rose, crimson seed heads. 37, 49, 59, 67, 83, 91, 169

Polygonum vaccinitifolium—1′ HT, pink flowers in late summer, good groundcover. 37

Potentilla: require well-drained soils, the flowers are five petalled and open, leaves are strawberrylike and hairy.

Potentilla alba—4″ HT, white flowers in late spring. 9, 37, 49, 121, 133

'Snow White'—longer blooming period. 95

Potentilla anserina—4″ HT, yellow flowers in spring, silvery plumelike leaves on red trailing stems, stoloniferous, invasive. 120

Potentilla argentea—1′ HT, sulphur-yellow flowers, leaves silvery tomentose beneath. 161

Potentilla arguta—3′ HT, creamy-white flowers in early summer, leaves pinnate and downy beneath. 127

Potentilla atrosanguinea—15″ HT, dark red flowers in late spring, silvery tomentose leaves. 3, 49, 95, 137, 159

'Firedance'—1′ HT, salmon-red flowers. 37, 65, 153, 159

'Gibson's Scarlet'—1.5′ HT, intense scarlet-red flowers in early summer. 9, 29, 37, 83, 107, 122, 159, 169

'Red'—2′ HT, purplish-red flowers. 161

Potentilla aurea—1′ HT, golden-yellow flowers in late spring, deeply cut toothed leaves, tomentose beneath. 3, 9, 83, 159, 161

'Nana'—3″ HT, dwarf form. 133

verna—3″ HT, golden-yellow flowers, evergreen leaves. 37, 65, 107, 153, 165, 171

Potentilla canadensis—yellow flowers, silky hairy prostrate stems. 41

Potentilla cinerea—2″ HT, bright yellow flowers in late spring, silvery-green palmate velvety leaves. 3, 37, 95, 133, 137, 161, 183

Potentilla fragiformis—10″ HT, golden-yellow flowers in summer, three-parted downy leaves. 61, 65, 139, 153, 159, 169

Potentilla gracilis—1′ HT, clear yellow clustered flowers in early summer, deeply cut silky tomentose beneath toothed leaves. 5

Potentilla grandiflora—10″ HT, golden-yellow flowers in summer, lobed and toothed leaves. 3, 161

Potentilla megalantha—4″ HT, bright yellow flowers in summer, large three-lobed deeply veined leaves, silvery beneath. 173

Potentilla nepalensis—1.5′ HT, rosy-red flowers in summer, palmately lobed and toothed leaves. 33

'Miss Willmott'—cherry-pink flowers. 3, 37, 49, 83, 97, 107, 117, 137, 139, 143, 159, 169, 171, 177, 183

'Roxanna'—rosy-orange flowers. 161

Potentilla nitida—1″ HT, rosy-pink flowers in late spring, small silky silvery leaves, requires excellent drainage. 95

Potentilla palustris—1.5′ HT, red-purple flowers in early summer, lobed and toothed gray-green leaves, requires damp to wet soils. 120

Potentilla pyrenaica - 10″ HT, golden-yellow flowers in early summer, five-lobed and toothed leaves, silky beneath, requires excellent drainage. 161

Potentilla recta—2′ HT, lemon-yellow flowers in early summer, hairy and divided leaves on upright stems. 49

'Warrenii'—large bright yellow flowers. 37, 61, 63, 65, 153, 177, 183

Potentilla reptans 'Pleniflora'—5″ HT, creeping double yellow flowers in early summer, palmately lobed toothed leaves, stolonferous. 83

Potentilla rupestris—1.5′ HT, pure white flowers with a yellow center in early summer, pinnate, toothed leaves. 52, 61, 95

Potentilla tabernaemontani (verna)—3″ HT, bright yellow flowers in spring, dark green lobed and toothed leaves, mat-forming, stoloniferous. 49, 67, 97, 143, 161

'Nana'—2″ HT, compact form. 9, 21, 83, 95, 97, 137, 159, 169

Potentilla thurberi—2′ HT, mahogany-red flowers in early summer, palmate coarsely toothed leaves. 97

Potentilla x *tonguei*—1′ HT, apricot-yellow flowers with a red center in early summer, lobed and toothed dark green leaves. 9, 37, 49, 61, 65, 67, 83, 95, 153, 165, 169, 171, 183

Potentilla tridentata—10″ HT, white flower clusters, three lobed, toothed leaves, blood-red fall color, stoloniferous. 21, 49, 67, 75, 153, 159, 165, 177

'Minima'—2″ HT, lower growing form. 9, 27, 37, 49, 144, 165

Potentilla villosa—1′ HT, yellow flowers in late spring, rosettes of compound toothed silky hairy leaves, white tomentose beneath. 9, 37, 49, 65, 109, 153. 173

Potentilla 'William Robinson'—1.5′ HT, orange-red flowers in summer, lobed and toothed leaves. 159

Potentilla 'Yellow Queen'—1′ HT, semidouble yellow flowers in early summer, lobed and toothed leaves. 37, 159, 171

Primula beesiana—2′ HT, large clear rose-carmine flowers with a golden eye in early summer, oblong crinkled leaves, requires moist to wet soil. 83, 159

Primula x *bullesiana*—2′ HT, shades of cream, orange, pink, crimson, purple and lilac flowers. 145, 159, 161

Primula bulleyana—2.5′ HT, clear deep yellow whorled flowers in summer, oval lance-shaped leaves, requires moist to wet soils. 52, 159, 161

Primula burmanica—1′ HT, reddish-purple flowers with yellow eyes in summer, oblong lance-shaped leaves. 161

Prunella *grandiflora*—1′ HT, purple flower spikes in early summer, narrow lance-shaped leaves, good groundcover, requires moist humus-rich soil. 3, 49, 52, 61, 83

'Alba'—white flowers. 49, 65, 159

'Loveliness'—large rose flowers. 37, 83, 153, 159, 177

'Pink Loveliness'—large pink flowers. 37, 61, 153, 169, 177

'Purple Loveliness'—large purple flowers. 177

'Rosea'—large rose flowers. 65, 83, 153

'Rotkappchen' ('Red Cap')—rose-red flowers. 49, 61

'Rubra'—red flowers. 83

'White Loveliness'—large pure white flowers. 37, 61, 153, 177

Prunella vulgaris—1.5′ HT, deep violet-blue short flower spikes in early summer, oval lance-shaped leaves on trailing stems. 115, 120, 183

Pterocephalus *parnassi (Scabiosa pterocephala)*—4″ HT, purplish-pink cornflowers, tufted featherlike densely pubescent leaves, fluffy seed heads, requires well drained soil. 29, 49, 65, 83, 137, 145, 153

Pycnanthemum *flexuosum*—3 HT, white clusters of flowers in late summer, narrow oblong leaves. 173

Pycnanthemum pilosum—3′ HT, pink flower clusters in summer, leaves lance-shaped finely toothed and hairy beneath. 69

Pycnanthemum tenuifolium—3′ HT, white buttonlike flowers in clusters in midsummer, narrow dense leaves. 173

Pycnanthemum virginianum—3′ HT, pink flower clusters in summer, lance-shaped finely toothed leaves. 9

Ranunculus *gramineus*—1′ HT, pale yellow flowers in early summer, glaucous grasslike leaves, prefers moist humus-rich soil. 3, 49, 145, 159

Ranunculus montanus—6″ HT, bright yellow flowers in spring, divided shiny green leaves, requires moist well-drained soil. 3

'Molten Gold'—golden-yellow flowers. 133, 145, 177

Ranunculus repens—1′ HT, yellow flowers in early summer, divided leaves, stoloniferous, invasive. 66, 97

'Pleniflorus'—double yellow flowers. 5, 173

Raoulia *australis*—5″ HT, pale yellow flowers in summer, spreading mats of evergreen tiny heart-shaped gray leaves, requires excellent drainage and protection from winter moisture. 83, 95, 145

Raoulia 'Greenstone'—5″ HT, small white daisy flowers in summer, leaves similar to *R. australis*, but olive green. 145

Raoulia monroei—1″ HT, small yellow daisies in summer, blue-green curled and twisted cushionlike leaves, requires excellent drainage and protection from winter moisture. 145

Ratibida *columnifera*—3′ HT, large yellow daisy flowers in summer with a brown central thimble cone, narrow leaves. 97

Ratibida pinnata—4′ HT, drooping yellow daisies with a central thimble cone in summer, narrow leaves. 25, 37, 107, 113, 127, 173

Rhazya *orientalis (Amsonia orientalis)*—1.5′ HT, gray-blue starlike flowers in early summer, blue-green narrow leaves on wiry stems, requires moist soil. 34, 159

Rheum *palmatum*—6′ HT, vivid cerise

flowers in fluffy panicles in early summer, large lobed and deeply cut leaves which are vivid red when emerging until flowering, attractive seed heads. 83

'Tanguticum'—4′ HT, white, pink and crimson flowers, less deeply cut leaves, tinted purple on both sides. 9

Rhexia virginica—1.5′ HT, rose, purple flowers with bright yellow anthers, lance-shaped leaves, rhizomatous, requires moist to wet soils. 157

'Martha's Furnace'—11

Rosularia pallida (chrysantha)—3″ HT, soft yellow tubular flowers in summer, greenish-gray hairy succulent rosettes of leaves. 145

Rosularia platyphylla—2″ HT, white flowers, bright green leaves tinged russet on the edge in rosettes, smooth and succulent. 145

Rudbeckia fulgida—2′ HT, orange-yellow daisies with a black central cone on stalks in midsummer, coarse oval leaves, rhizomatous, can be invasive, will tolerate shade, requires well drained soil. 52, 109, 113, 115, 123, 157

'Goldsturm'—deep yellow flowers with black centers through October. 3, 9, 21, 27, 29, 34, 37, 39, 49, 65, 83, 91, 95, 97, 107, 117, 122, 133, 137, 153, 157, 159, 165, 169, 171, 175, 177

speciosa—3′ HT, orange-yellow flowers with a brown central cone. 3, 9, 37, 83

sullivantii—larger flowers with somewhat drooping petals. 117, 157

Rudbeckia hirta—3′ HT, yellow flowers with a brown central cone in summer, coarsely hairy oval leaves, short-lived perennial. 5, 52, 63, 66, 107, 113, 123, 127, 144, 157

'Autumn Leaves'—75

'Gloriosa'—mixed flowers of red, yellow, orange. 27, 33, 39, 63, 75

'Marmalade'—3′ HT, yellow and mahogany flowers. 33

pulcherrima (serotina)—yellow flowers with a purple-black central ring. 120

Rudbeckia laciniata (nitida)—7′ HT, yellow flowers with a green central cone in midsummer, deeply lobed and compound leaves. 3, 41, 117

'Autumn Glory'—large yellow flowers. 91, 165

'Gold Ball'—3′ HT, double flowers. 41

'Gold Drop' ('Goldquelle')—2.5′ HT, double yellow flowers. 37, 39, 65, 83, 95, 107, 153, 159, 165, 177

'Goldilocks'—2.5′ HT, bright gold double and semidouble flowers with a dark central cone. 33, 37, 175

'Golden Glow' ('Hortensia')—double yellow flowers. 49, 159

'Herbstonne' ('Autumn Sun')—5′ HT, light yellow flowers with a green central cone, weak stemmed, requires support. 9, 21, 34, 37, 49, 83, 95, 159, 165

Rudbeckia 'Monarch'—33

Rudbeckia subtomentosa—4′ HT, clear yellow flowers with a dark central cone in late summer, downy divided leaves. 49, 127

Rudbeckia triloba—4′ HT, orange-yellow flowers with a brown cone in midsummer to fall, oval, lobed leaves, more refined than *R. fulgida*, short-lived perennial. 113, 115, 117, 181

Ruellia caroliniensis—1′ HT, small blue trumpet flowers in early summer, lance-shaped leaves. 123, 173

Ruellia ciliosa—1′ HT, light lavender-blue trumpet flowers in summer, lance-shaped leaves. 177, 181

Ruellia humilis—8″ HT, similar to *R. caroliniensis*, but more spreading. 11, 173

Ruellia strepens—2′ HT, pale blue-violet flowers in summer, dark green oval leaves. 63, 173

Sagina procumbens—133

Salvia: all require excellent drainage.

Salvia argentea—4′ HT, white flowers in summer, large basal woolly white leaves, short-lived perennial. 49, 159, 175

Salvia azurea grandiflora (pitcherii)—5′ HT, pure blue flower spikes in late summer, smooth narrow leaves. 9, 29, 34, 37, 49, 65, 95, 153, 159

Salvia clevelandii—3′ HT, bright blue flower spikes in whorls in fall, narrow silver aromatic leaves, tender. 37, 98

Salvia dorisiana—4′ HT, magenta flowers in fall, thin velvety heart-shaped leaves, tender. 98

Salvia farinacea—3′ HT, blue flower spikes in summer, shiny oval gray-green leaves, tender. 183

'Blue Bedder'—dark blue flowers. 157, 183

'Blue Spike'—blue flowers. 183

'Silver White'—white flowers, silvery white leaves. 183

'Victoria'—1.5′ HT, compact habit. 117, 157

Salvia fruticosa—4′ HT, purple to pink flower spikes in summer and fall, gray-green soft fragrant leaves. 183

Salvia glutinosa—3′ HT, pale yellow flower spikes in late summer, aromatic leaves. 52, 69, 173

Salvia greggii—3′ HT, rose-red flowers in fall, small narrow aromatic leaves, tender. 95

'Rosea'—pale red flowers. 98

Salvia guaranitica—5′ HT, dark blue flower spikes in summer, coarse crinkled green leaves. 181

Salvia jurisicii—2′ HT, violet-blue flower spikes, compound linear leaves. 177

Salvia leucantha—3′ HT, violet and white flower spikes in summer and fall, pointed, wrinkled gray leaves, white beneath, tender. 34, 37, 98, 181

Salvia lyrata—2′ HT, lavender flower spikes in spring, lyre shaped rosettes of leaves, evergreen. 49, 69, 157, 173, 183

Salvia mellifera—5′ HT, lavender-blue flowers in summer, oblong dark gray-green leaves, tender. 69

Salvia patens—2′ HT, sky-blue flower spikes in summer, soft hairy arrow-shaped leaves, tender. 98

Salvia pratensis (haematodes)—3′ HT, violet-blue flower spikes in summer, oblong coarse crinkled leaves, short-lived perennial. 69, 153, 161, 177

'Indigo Spires'—indigo-blue flowers. 98, 159, 171

'Midsummer'—pale indigo-blue flowers. 159

Salvia x *superba*—3′ HT, violet flowers in early summer, reblooms in fall if cut back, lance-shaped green crinkled leaves, prefers rich soil. 9, 49, 52, 83, 109, 159, 161, 165

'Blauhugel'—1.5′ HT, pure blue flowers. 83

'Blue Queen'—1.5′ HT, intense deep blue flowers. 3, 21, 49, 52, 61, 159, 161, 165, 169, 175, 177

'Compacta'—15″ HT, deep blue flowers. 37

'East Friesland' ('Ostfriesland')—1.5′ HT, violet-purple flowers. 9, 21, 27, 29, 37, 39, 65, 77, 91, 98, 107, 122, 133, 153, 159, 165, 169, 171, 175

'May Night' ('Mainacht')—2′ HT, dark indigo-violet flowers with purple bracts. 29, 37, 83, 91, 159, 169, 171

'Rose Queen'—2′ HT, bright pink flowers on rose tinted stems. 37, 49

'Rosea'—2′ HT, rose-pink flowers. 175

Salvia uliginosa—6′ HT, blue flowers in fall, broad saw-edged leaves, requires moist soils, tender. 34, 49, 95, 98, 109, 117

Salvia verticillata—3′ HT, pinkish-mauve flowers, gray-green leaves, tender. 109

Santolina *neapolitana*—2.5′ HT, yellow buttonlike flowers in summer, feathery silver dissected aromatic leaves, requires sandy soil and excellent drainage, tender. 37, 65, 69, 91, 144

Santolina pinnata—1.5′ HT, white buttonlike flowers in summer, feathery dark gray-green leaves, requires sandy soil and excellent drainage, tender. 37, 165

Santolina virens (ericoides and viridis)—2′ HT, yellow buttonlike flowers in summer, bright green feathery dissected aromatic leaves, requires excellent drainage and sandy soil. 9, 21, 37, 49, 52, 61, 65, 69, 91, 98, 144, 159, 165, 175

Saponaria *lutea*—6″ HT, bright yellow flowers in late spring, lance-shaped clump-forming leaves, requires sandy well drained soils. 65, 153

Saponaria ocymoides—9″ HT, pink flowers in early summer, semievergreen small oval leaves on trailing stems, requires sandy well-drained soils. 3, 5, 9, 21, 33, 37, 49, 65, 77, 83, 95, 107, 133, 137, 153, 159, 169, 177, 183

'Alba'—white flowers. 9, 37

'Rubra Compacta'—6″ HT, deep pink flowers, more compact habit. 37

'Splendens'—4″ HT, deep rosy-pink flowers. 97, 171

Saponaria officinalis—3′ HT, pink or white flower clusters in summer, oval lance-shaped leaves on weak stems, rhizomatous, invasive, requires sandy well-drained soils. 52, 66, 120, 175

'Flore Pleno'—double white or pink fragrant flowers. 49

'Rosea Plena' ('Rubra Plena')—double rose-pink fragrant flowers. 9, 27, 37, 109, 159

'Rubra'—light pink flowers. 83

Saponaria x *olivana* - 3″ HT, bright rose-pink flowers in early summer, narrow green clump-forming leaves, requires sandy well-drained soils. 137

Saponaria pumila—3″ HT, rose or white flowers in early summer, linear leaves in dense tufts, requires sandy well-drained soils. 133

Satureja *douglasii*—2″ HT, white mintlike flowers, oval leaves on trailing stems, requires sandy well-drained soils. 69, 98

Satureja georgiana—2′ HT, pink flowers in summer, elliptic leaves, requires sandy well-drained soils, tender. 77

Satureja glabella (arkansana)—4″ HT, small purple flowers in spring, dark green oblong lance-shaped aromatic leaves on prostrate stems, requires sandy well-drained soils, tender. 121

Saxifraga *michauxii*—1′ HT, white flower clusters in early summer, toothed reddish rosettes of leaves. 66, 173

Saxifraga virginiensis—1′ HT, white or green flowers in spring, toothed oval rosettes of leaves. 66, 173

Scabiosa 'Blue Snowflake'—2.5′ HT, large sky-blue flowers with pink anthers in summer. 95

Scabiosa caucasica—2.5′ HT, flat heads of blue flowers in summer, lance-shaped dissected basal leaves, requires good drainage. 3, 37, 63, 75, 177

'Alba'—white flowers. 65, 153, 159, 171, 177

'Blue Perfection'—lavender-blue flowers. 97, 171

'Clive Greaves'—lavender blue flowers. 107

'Compliment' ('Kompliment')—dark lavender flowers. 159, 169

'Fama'—clear blue flowers. 9, 37, 159

'Goldingensis'—lavender blue flowers. 83

'Isaac House Hybrids'—mix flowers of blue shades. 37, 83, 107, 159, 169, 177, 183

'Miss Willmott'—creamy white flowers. 83, 95

'Perfecta'—large blue flowers. 65, 153

'Perfecta Alba'—large white flowers. 52, 169

Scabiosa columbaria—2.5′ HT, balls of pink and lilac flowers in summer, oblong lance-shaped leaves. 61

Scabiosa graminifolia—1′ HT, pale blue flowers in summer, linear silvery pubescent leaves, rhizomatous. 3

Scabiosa japonica alpina—blue flowers, dissected leaves. 3

Scabiosa ochroleuca—3′ HT, small pale yellow pincushion flowers in midsummer to fall, dissected glaucous leaves. 49, 61, 159, 161

Schivereckia podolica—10″ HT, white flower clusters in spring, oblong lance-shaped toothed leaves in dense tufts, requires well-drained soils. 161

Scutellaria: prefer rich moist soils.

Scutellaria indica parvifolia—4″ HT, purple spikes of hooded flowers in early summer, fuzzy round leaves. 54

Scutellaria integrifolia—2′ HT, bluish white hooded flowers in early summer, lance-shaped leaves. 123

Scutellaria orientalis pinnatifida—4″ HT, yellow hooded flowers in summer, dissected gray leaves on spreading mats. 145

Scutellaria scordiifolia—1.5′ HT, violet-blue hooded flowers on short spikes in summer, oblong toothed leaves. 121, 153

Sedum: require sandy well-drained soils, have succulent leaves and small starlike flowers arranged in clusters.

Sedum acre—4″ HT, bright yellow flowers in late spring, small thin succulent leaves, mat-forming, evergreen, invasive. 9, 63, 65, 75, 83, 97, 107, 153, 183

'Aureum'—tips of shoots are bright yellow. 133, 159

'Mural Coral Carpet'—pink flowers. 83

Sedum aizoon 'Auranticum'—15″ HT, deep yellow flowers in summer, dark green lance-shaped leaves with bronze stems, long tuberous roots on knotty rootstocks. 37, 144, 159, 171

Sedum album—8″ HT, flat white flowered panicles in early summer, thin oblong leaves, creeping, evergreen. 3, 37, 65, 67, 83, 91, 137, 153

'Athoum'—small leaves. 144

'Chubby Fingers'—plumper leaves. 37

'Coral Carpet'—salmon-orange highlights on new growth. 37, 133

'Golden Carpet'—golden-yellow leaves. 83

'Laconicum'—bronze leaves. 83

'Micranthum'—1/4″ HT, tiny leaves. 133, 144, 183

'Murale'—purple leaves and pink flowers. 83, 144, 159, 169

'Murale Nigra'—pink flowers and dark purple leaves. 65, 153

Sedum anacampseros—6″ HT, creeping habit, purple flowers in summer, evergreen glaucous leaves. 3, 95, 133

Sedum anglicum 'Minus'—creeping habit, deep pink flowers in early summer, crowded elliptic gray-green rosettes of leaves, evergreen. 133

Sedum 'Autumn Joy'—18″ HT, pale pink flowers deepening to rosy-red and then coppery-bronze in winter, gray-green leaves. 3, 9, 21, 27, 29, 34, 37, 39, 49, 65, 77, 83, 91, 95, 97, 107, 109, 117, 122, 133, 137, 144, 153, 157, 159, 165, 169, 171, 175, 177, 183

Sedum bithynicum (glaucum)—rose-purple flowers in early summer, crowded oblong leaves resembling a fleshy tail. 54, 83, 144, 153

Sedum brevifolium—2″ HT, white flowers in early summer, mealy gray leaves arranged in four rows, evergreen. 65, 133, 144, 153

Sedum cauticola—8″ HT, brilliant rosy-red flowers in early fall, rounded glaucous leaves on trailing stems, will tolerate moist soils. 9, 27, 133, 144, 153, 173, 183

'Likadense'—blue-green leaves with a red edge. 37, 83, 95

'Purple Carpet'—rosy-purple flowers. 3

Sedum crassula alpina—65, 153

Sedum cyaneum—4″ HT, lilac to pink flowers in summer, oblong lanceolate glaucous leaves on trailing stems. 144

Sedum dasyphyllum—2″ HT, pink flowers in late spring, small round cylindrical gray leaves, evergreen. 3, 95, 98, 144, 159, 183

'Blue Carpet'—133

glandulifernm (corsicum)—densely pubescent leaves. 37, 144

'Riffense'—37, 144

Sedum divergens—prostrate habit, bright yellow flowers in summer, shiny red globular leaves on creeping mats. 3

Sednm 'Emerald Carpet'—4″ HT, yellow flowers in summer, small emerald-green leaves in dense mats. 49, 63

Sedum x *erythrostictum (alboroseum)*—1.5′ HT, pink flowers in late summer.

'Medio-variegatus'—cream and gold rounded toothed leaves. 159

'Variegatum'—gray-green leaves with a wide creamy center. 49, 54, 109

Sedum ewersii—1′ HT, purplish-pink to red flowers in late summer, broad rounded blue-gray leaves on trailing stems. 9, 65, 83, 95, 144, 153, 159, 183

'Homophyllum'—3″ HT, dwarf form. 3, 83, 133

Sedum floriferum 'Weihenstephaner Gold'—6″ HT, yellow flowers in early summer, thick green leaves on spreading stems. 3, 21, 37, 49, 83, 91, 121, 144, 159, 165, 169

Sedum glaucophyllum—6″ HT, white flowers in late spring, flat glaucous rosettes of leaves, evergreen. 65, 109, 173

Sedum 'Golden Carpet'—4″ HT, golden-yellow flowers in early summer, compact mats of green leaves. 169

Sedum gracile—2″ HT, white flowers in early summer, grass-green needlelike leaves. 133, 137

Sedum gypsicola—6″ HT, white flowers in summer, light green leaves with red markings on thick prostrate stems, tender. 144

Sedum hispanicum—3″ HT, white flowers.

'Aureum'—linear cylindrical leaves edged with yellow. 37

'Minus'—1″ HT, dwarf form. 3, 133

Sedum hybridum—creeping habit, yellow flowers in late spring, evergreen. 41, 97, 144

Sedum kamtschaticum—1″ HT, yellow flowers in midsummer, dark green scalloped leaves on trailing stems. 27, 37, 49, 65, 67, 83, 95, 109, 133, 153, 159, 165, 169, 177, 183

'Diffusum'—more compact form of species. 37

ellacombianum—large yellow flowers, toothed spatulate leaves. 21, 37, 95, 107, 159, 169, 183

kamtschaticum—37, 107, 169, 173

middendorffianum—thin oblong lance shaped toothed leaves. 83, 95, 159, 183

'Striatum'—narrow needlelike leaves turning red in fall. 133

'Taka Hira Daki'—3, 144

'Variegatum'—pale green leaves variegated with yellow, pink and red. 3, 37, 49, 53, 61, 83, 95, 159, 165, 169

Sedum lineare 'Variegatum'—6″ HT, yellow flowers in summer, pale green needlelike leaves edged with white on prostrate stems, evergreen, tender. 117

Sedum lydium—6″ HT, white flowers with red calyces in early summer, short cylindrical green leaves tinged with red. 183

Sedum maximum (caucasicum)—3″ HT, greenish white flowers in late summer. 144

'Atropurpureum'—reddish flowers in flat clusters, smooth rich dark maroon leaves.

'Honeysong'—2″ HT, creamy-rose flowers, mahogany-purple leaves. 37

Sedum mexicanum—6″ HT, yellow flowers in spring, needlelike whorled leaves on trailing stems, tender. 54

Sedum montregalense—6″ HT, white flower spikes in summer, spatulate leaves on trailing stems. 3

Sedum 'Moonglow'—2″ HT, yellow flowers, silvery rosettes of leaves, pale green, golden-apricot when first opening, tender. 145

Sedum nevii—4″ HT, small white flowers with rosy anthers in early summer, silvery spatulate leaves touched with pink. 3, 77, 95, 98, 109, 133, 144, 183

Sedum nussbaumeranum—6″ HT, pure white flowers in early spring, greenish yellow leaves with rust edges, tender. 183

Sedum ochroleucum (anopetalum and *montanum)*—prostrate habit, white flowers in early summer, evergreen linear spiny-tipped leaves. 144

Sedum oreganum (watsonii)—6″ HT, yellow flowers fading to pink in summer, green tinged red leaves. 3, 95, 144, 159

Sedum oregonense—10″ HT, creamy white flowers in summer, yellow-green spatulate leaves. 95

Sedum pachyclados—blue spatulate leaves. 37, 133, 144

Sedum pluricaule—3″ HT, round clusters of purple flowers in summer, oval leaves on creeping stems. 133, 144

'Rosenteppich'—gray leaves. 65, 153, 159

'Yezoensis'—white flowers. 144

Sedum purdyi—4″ HT, clusters of white flowers in spring, small rounded leaves in overlapping tight rosettes, stoloniferous, will grow in partial shade. 145

Sedum reflexum—1″ HT, bright yellow flowers in summer, short densely set linear leaves, evergreen. 107, 137, 159, 169

'Oxbow Hybrid'—6″ HT, blue-gray leaves, bronze in winter. 9, 37, 65, 83, 153

Sedum rosea (Rhodiola rosea)—1″ HT, greenish yellow to yellow-purple flowers in late spring, deep pink flower buds, small glaucous toothed leaves. 3

Sedum 'Rosy Glow' ('Ruby Glow')—8″ HT, red flowers opening to crimson in late summer, flowers turn brown and remain on plant through winter, gray-blue spatulate leaves. 3, 9, 21, 34, 37, 49, 65, 83, 91, 95, 97, 107, 109, 144, 159, 165, 169, 177, 183

Sedum rupestre (pruinatum and cristatum)—6″ HT, pale yellow flowers in early summer, bluish green leaves turn purple in fall and remain through winter, tender. 21, 95, 165

'Blue Spruce'—bluish leaves arranged like small spruce tree. 63, 183

'Forsteranum'—similar to 'Blue Spruce'. 95

'Sandy's Silver Crest'—similar to 'Blue Spruce' but tips are cream in late summer. 133

Sedum sarmentosum—6″ HT, yellow flowers in early summer, lanceolate leaves in threes, evergreen. 65, 153, 183

Sedum sediforme (nicaeense)—2′ HT, white flowers in summer, glaucous lance-shaped leaves. 9, 144, 159

Sedum sexangulare—3″ HT, deep yellow flowers in summer, linear leaves in six spiral rows, creeping habit. 3, 21, 65, 83, 91, 144, 153, 159, 165, 183

Sedum sieboldii—9″ HT, pink flowers in late summer to fall, glaucous rounded leaves in whorls of three. 9, 21, 37, 41, 65, 95, 137, 144, 153, 159, 165, 173, 177, 183

'Medio-variegatum'—leaves variegated in center. 159

'Variegatum'—variegated leaves. 3, 37, 65, 83, 98, 137, 153

Sedum sordidum—15″ HT, large cluster of white and yellow flowers in late summer, broad purple-tinged leaves. 173

Sedum spathulifolium—prostrate habit, yellow flowers in summer, small glaucous rosettes of spatulate leaves. 95, 183

'Cape Blanco'—leaves gray, dusted with white. 3, 37, 83, 95, 133, 145, 159

'Purpureum'—purple leaves. 3, 95, 145

Sedum spectabile—18″ HT, rosy-pink flat topped clusters of flowers in late summer through frost, gray-green leaves, stems remain ornamental through winter. 33, 41, 63

'Atropurpureum'—dark red flowers. 37, 165

'Brilliant'—raspberry-carmine flowers. 3, 21, 37, 49, 65, 83, 107, 137, 153, 159, 165, 169

'Carmen'—deep pink flowers. 37, 95, 144, 183

'Meteor'—deep pink flowers. 37, 65, 95, 153, 165, 171, 177, 183

'Star Dust'—ivory-white flowers. 37, 65, 83, 95, 107, 153, 159, 165, 177

'Variegatum'—bright red flowers, cream variegated leaves. 37, 45, 95, 97, 107, 133, 137, 144

Sedum spurium—6″ HT, pink to white flowers in midsummer, evergreen oval gray-green leaves with waxy edge turning red in fall and remaining through winter, mat-forming. 133

'Album Superbum'—white flowers. 21, 91, 144, 159

'Bronze Carpet' ('Purpurteppich')—pink flowers, bronze leaves. 9, 37, 63, 65, 83, 153, 165, 169

'Coccineum'—deep red flowers. 21, 107, 165

'Dragon's Blood'—brilliant red flowers, purple-bronze foliage. 3, 27, 37, 49, 63, 65, 67, 83, 97, 115, 137, 144, 153, 159, 169, 171, 175, 183

'Elizabeth'—rose-pink flowers, bronze-maroon leaves. 145

'Fuldaglut'—rose-red flowers, reddish leaves. 37, 59, 83, 91, 133

'Red Carpet'—better red color than 'Dragon's Blood'. 3, 49, 67, 97, 169, 183

'Royal Pink'—pink flowers. 37, 183

'Tricolor'—2″ HT, pale pink flowers, wavy-edged green, cream and deep pink leaves. 37, 133, 144, 159, 183

'Variegata'—variegated leaves. 83, 183

Sedum stefco - 133

Sedum stenopetalum (douglasii)—16″ HT, yellow flowers in summer, linear lanceolate leaves. 133, 159, 183

Sedum stoloniferum—1′ HT, pink flowers in late summer, dark green leaves. 95, 144, 169, 183

'Album'—white flowers. 83, 95

'Coccineum'—deep bronze leaves. 95

Sedum 'Sunset Cloud'—1.5′ HT, pink flowers in summer, reddish serrated leaves. 37

Sedum 'Vera Jameson'—1′ HT, dusky pink flowers in late summer, glaucous deep purple flowers on arching stems. 34, 37, 49, 77, 91, 109, 159

Sedum 'Yellow Carpet'—bright yellow flowers in summer, dense dark green leaves. 67

Sempervivella alba—133

Sempervivum—all are prostrate evergreen succulents with slowly creeping dense rosettes, flowers are on 3-10″ stalks in summer, and require excellent drainage.

Sempervivum albidum—rosettes of gray-green leaves. 159

Sempervivum allionii—6″ HT, greenish white flowers, closed pale green rosettes. 183

Sempervivum 'Alpha'—bronze rosettes with narrow leaves. 37, 183

Sempervivum arachnoideum—4" HT, bright red flowers, leaf tips connected with cobwebby strands. 9, 37, 83, 95, 121, 144, 159, 169, 183

'Cebense'—very large and heavily webbed rosettes. 137

'Elegans'—wider and fuzzy rosettes. 159

'Ford's Spring'—gray-green leaves tinged red. 95

glabrescens (moggridgei)—small gray leaves. 83

'Icicle'—frosted silver rosettes tinged with red. 95, 137, 144

'Kappa'—9

'Laggeri'—tiny rosettes. 159

'Major'—tiny rosettes with purple-green edging. 137

'Mayfair'—large rosettes in red shades. 137, 159

'Raspberry Ice'—pink flowers with silver hairs. 137

'Safari'—light green rosettes with reddish outer leaves. 137

'Shirley's Joy'—light green rosettes with cobwebs. 137

'Stansfieldii'—flat topped bright red flower clusters. 137

'Tomentosum'—rosettes with woolly cobwebs. 9, 133, 159

'Webbianum'—rosettes with heavy webbing. 159

Sempervivum 'Ashes of Roses'—rosettes with gray fuzz. 159

Sempervivum x *barbulatum (elegans* and *bookeri)*—soft gray and red leaves. 95, 133

Sempervivum 'Bedivere'—rosettes of globular pink leaves. 159

Sempervivum 'Beta'—small fuzzy red-lavender rosettes. 159

Sempervivum 'Blood Tip'—sharp red-tipped rosettes. 83, 95, 137, 159

Sempervivum 'Booth's Red'—large deep red rosettes. 137

Sempervivum 'Bromeri'—lime-green rosettes with a purple center. 95

Sempervivum 'Carmen'—open bright green rosettes. 9, 159

Sempervivum 'Carniolocum'—small silver-green rosettes. 159

Sempervivum ciliosum borisii—4" HT, greenish yellow flowers, rosettes of frosty light green globular leaves. 83, 137

'Red'—bright red-green rosettes. 137

'Purple'—red to purple on undersides of leaves. 137

Sempervivum 'Clarinda'—large lime-green rosettes. 95

Sempervivum 'Cleveland Morgan'—large dusky pink rosettes. 9, 159

Sempervivum 'Collage'—lacy green and red rosettes. 137

Sempervivum 'Commander Hay'—fringed large red and green rosettes. 83, 137, 159

Sempervivum 'Comollii'—golden-copper rosettes with a green center. 95

Sempervivum 'Dr. Perry Goldsmith'—variegated red and gray rosettes. 83

Sempervivum 'Emerald Giant'—large frosty pink rosettes in winter. 37

Sempervivum 'Engles 13-2'—powdery lavender rosettes. 159

Sempervivum 'Engle's Rubrum'—glaucous purple rosettes of toothed leaves. 37

Sempervivum x *fauconnettii*—8" HT, bright red flowers, leaves tinged with red and purple. 137, 159

Sempervivum x *fimbriatum*—10″ HT, bright red flowers, bronze leaves with hairy ridges. 159

Sempervivum 'Flamingo'—large pointed coral-pink rosettes. 95, 137

Sempervivum 'Flasher'—sharp pointed maroon-red rosettes with a green center. 95

Sempervivum x *funckii*—small green hairy rosettes. 133

Sempervivum 'Galahad'—medium green rosettes with purple tips. 159

Sempervivum 'Gloriosum'—144

Sempervivum 'Glowing Embers'—smooth olive-green rosettes with red tips. 137

Sempervivum 'Granada'—velvety rose-wine and gray rosettes. 137

Sempervivum 'Grigg's Surprise'—gray-green rosettes of thin cylindrical leaves. 137

Sempervivum 'Giuseppi'—rosettes of globular green velvety leaves. 137

Sempervivum 'Giuseppi Pena Espiquena'—flat rosettes of pointed green leaves with brown edges. 137

Sempervivum 'Havana'—large chartreuse rosettes with purple tips. 95

Sempervivum 'Helvatica'—small gray rosettes. 37

Sempervivum heuffelii—large smooth light green rosettes with rosy-red tips. 137

'Apache'—6″ HT, pale yellow flowers, blue-green to purple rosettes with hairy edges. 37

Sempervivum 'Hey Hey'—globular green leaves with hairy edges. 137

Sempervivum hirtum—8″ HT, pale yellow to greenish white flowers in summer. 'Rintis'—37

Sempervivum histonii—globular green and red rosettes. 95

Sempervivum 'Hita Borealis'—144

Sempervivum 'Hot Shot'—rusty rosettes with a gray-green center. 37

Sempervivum 'Imperial'—pale green rosettes tinged with dusty rose. 159

Sempervivum 'Jewel Case'—globular green rosettes tinted rose with long hairs. 137

Sempervivum 'J.P. Morgan'—very large gray-green rosettes. 159

Sempervivum 'Kalinda'—large globular maroon rosettes. 159

Sempervivum 'King George'—gray-green rosettes. 159

Sempervivum 'Laura Lee'—deep bronze purple rosettes with hairy edges. 37

Sempervivum 'Lavender and Old Lace'—rosettes edged with silver and a rosy center. 37, 95, 159

Sempervivum 'Malbyi'—flat red rosettes. 159

Sempervivum marmoreum—6″ HT, crimson and white flowers, red rosettes with green tips. 137

'Brunneifolium' (ornatum)—translucent satiny red rosettes with green centers. 37, 159

'Rubicundum' *(schlehanii)*—carmine-red rosettes with green tips. 37, 159, 183

Sempervivum 'Mitchell's Variety'—red tipped rosettes. 159

Sempervivum montanum—6″ HT, bluish-purple flowers, dark green leaves with dense hairs. 37, 83, 95, 159, 169, 183

braunii—pure green rosettes. 83, 159, 169

'Globuliferum'—37, 95, 183

Sempervivum 'Nigrum'—green rosettes with purple tips. 159

Sempervivum 'Oddity'—apple-green rosettes tinted with purple on needlelike leaves. 37, 95

Sempervivum 'Ohio Burgundy'—large deep red rosettes. 37, 137

Sempervivum 'Old Rose'—dusty lavender-rose rosettes. 137, 159

Sempervivum 'Othello'—large strong red rosettes. 144, 159

Sempervivum 'Patrician'—translucent orange-red rosettes. 137, 159

Sempervivum 'Pekinese'—small light green rosettes tipped with pink. 37, 159

Sempervivum 'Piloseum'—large gray-green rosettes. 169

Sempervivum 'Poke Eat'—fuzzy green-red rosettes. 137

Sempervivum 'Purdy's 90-1'—gray-green velvety rosettes tinted rose. 37, 95

Sempervivum 'Raspberry Ice'—large maroon rosettes accented with silvery white. 95

Sempervivum 'Red Beauty'—red rosettes. 83, 169, 183

Sempervivum x *rupicola (theobaldii)*—green velvety rosettes tinged red. 137

Sempervivum 'Rubikon Improved'—red rosettes. 37

Sempervivum 'Ruby Heart'—silvery blue rosettes with ruby red center. 137

Sempervivum 'Rubra Ray'—large open rosettes with a red center. 37, 137

Sempervivum 'Sanfordii'—large broad rich mahogany-rose rosettes. 95, 137, 169

Sempervivum 'Saturn'—violet-red rosettes. 159

Sempervivum 'Silverene'—large silver blue and pink rosettes. 83, 137, 169

Sempervivum soboliferum (javibarba)—6" HT, greenish-yellow flowers, small globular green rosettes with red tips. 121, 133, 137, 159, 169

'Sun Dancer'—closed green rosettes with red tips. 137

Sempervivum 'Spinel'—gray and blue variegated rosettes. 83

Sempervivum 'Stuffed Olive'—small globular green and red rosettes. 95

Sempervivum tectorum—1' HT, pink flowers, gray rosettes. 37, 83, 137, 159, 183

alpinum—pale blue rosettes. 159

'Atropurpureum'—narrow dark crimson rosettes with green edges. 37, 83, 137, 159, 183

'Atroviolaceum'—rose-wine rosettes edged with silver fading to violet-green. 137, 159

'Bicolor'—gray-blue rosettes. 83

'Rubrum Borsch'—red rosettes. 83

'Snowberger'—misty soft grey rosettes. 159

'Tokajense'—large wine-red pointed rosettes. 137

'Violaceum'—deep maroon-purple pointed rosettes. 95

Sempervivum 'Thayne'—large silver-green rosettes. 159

Sempervivum 'Thomsonii'—small globular gray-green rosettes. 159

Sempervivum 'Traci Sue'—globular amber-green rosettes with a rose center. 95, 159

Sempervivum 'Twilight Blues'—large deep wine-red rosettes changing to soft blue in fall. 137

Sempervivum 'Ustchio'—densely tomentose white rosettes. 37

Sempervivum 'Westchester'—woolly silvery-gray rosettes. 95

Sempervivum 'Witcheri'—small dense woolly gray rosettes. 159

Sempervivum 'Wolcott's Variety'—gray-green rosettes flushed with maroon. 95

Sempervivum 'Zenobia'—crowded emerald-green rosettes with darker markings. 37

Senecio aureus—2' HT, deep yellow flowers in spring, oval toothed leaves. 120, 181

Senecio tanguticus—5' HT, small yellow daisy-

like flowers in early fall, divided leaves, fluffy pale seed heads, rhizomatous, invasive. 9, 159

Sibbaldia *procumbens*—4″ HT, small yellow-green flowers in spring, narrow wedge-shaped gray-green leaves. 153

Sidalcea 'Brilliant'—2.5′ HT, carmine-red flower spikes in summer, shiny basal heart-shaped leaves, requires good drainage. 9, 29, 83, 107

Sidalcea 'Elsie Heugh'—3′ HT, pale pink flowers with fringed petals in summer. 9, 29, 83, 159, 171

Sidalcea malviflora—2′ HT, rosy flowers, shiny lobed heart-shaped leaves. 63

'Stark's Variety'—5′ HT, rosy-red flowers. 159

Sidalcea 'Mr. Lindbergh'—2.5′ HT, rosy-red flowers. 29

Sidalcea 'New Hybrids'—mixed flowers of pink, rose and red. 65, 153

Sidalcea oregana—2′ HT, loose spikes of rose-pink flowers in early summer, finely cut and lobed leaves, rhizomatous, prefers moist soils. 5

Sidalcea 'Rosy Gem'—4′ HT, rose-pink flowers. 9, 159

Sidalcea 'Sussex Beauty'—2.5′ HT, clear pink flowers. 29, 37

Sidalcea 'Sylvia Dawkins'—3′ HT, rose-pink flowers. 95

Sidalcea 'William Smith'—3.5′ HT, bright salmon-pink flowers. 159, 171

Silene: require good drainage and have notched or frilled petals.

Silene acaulis—4″ HT, reddish purple flowers in late spring, mosslike leaves forming clumps. 95, 161

Silene caroliniana—9″ HT, pink flowers in summer, sticky narrow blue-green leaves, short-lived perennial.

'Millstream Pink'—clear pink flowers. 54

wherryi—4″ HT, bright pink flowers in late spring. 54, 137, 159, 173

Silene compacta (orientalis)—4′ HT, rose flowers in summer, basal rosettes of lance-shaped leaves, short-lived perennial. 52

Silene dioica 'Flore Plena' *(Lychnis dioica* 'Flore Plena')—2′ HT, bright pink flower clusters in summer, dark hairy oval leaves. 95

Silene hookeri—4″ HT, salmon-pink to white deeply cleft flowers, furry gray spatulate leaves, requires a dry rest period in midsummer. 145

Silene keiskei—8″ HT, pink to white cleft flowers in summer, small linear lanceolate pale green leaves. 117

'Caesalpina'—4″ HT, deep pink flowers in late summer. 133

Silene quadridentata (pusilla)—1′ HT, white flower clusters in summer, linear-lanceolate leaves. 3, 161

Silene quadrifida (alpestris)—6″ HT, white flowers in early summer, lance-shaped leaves. 3, 52, 61, 97, 161

'Flore Plena' double white flowers. 95, 133, 145

Silene regia—4′ HT, bright scarlet flowers in summer, downy finely divided leaves. 61

Silene saxifraga—6″ HT, white to green flowers, red beneath, in early summer, densely tufted hairy linear leaves. 3, 52, 137, 161

Silene schafta—6″ HT, bright pink flowers in late summer, hairy narrow light green leaves in dense tufts. 37, 95, 133, 183

'Splendens'—8″ HT, rose flowers. 3, 9, 159

Silene stellata—3′ HT, white deeply cleft and fringed flowers in early summer whorled lance-shaped leaves. 66

Silene vallesia—6″ HT, pink flowers, red beneath, in summer, lance-shaped to linear leaves on mat-forming stems. 3, 161

Silene virginica—2′ HT, bright scarlet notched flowers in early summer, narrow lance-shaped

leaves. 61, 66, 113, 115, 117, 121, 123, 139, 144, 157, 173

Silene vulgaris—1.5′ HT, fringed pink and white flowers with inflated striped base in summer, densely tufted blue-green leaves, requires sandy soil. 3, 37, 139

'Flore Plena' ('Robin White Breast')—double white flowers. 37, 65, 137, 145, 153, 165

Silene zawadskii—8″ HT, white flowers in early summer, hairy elliptic tufts of leaves. 49, 52, 161, 183

Silphium laciniatum—10′ HT, yellow daisy-like flowers in late summer, large pinnately dissected leaves, requires moist fertile soils. 107, 127

Silphium perfoliatum—8′ HT, yellow flowers in summer, coarse triangular leaves surrounding a square stem. 25, 107, 127, 181

Silphium terebinthinaceum—8′ HT, yellow flowers in late summer, large thick heart-shaped leaves. 127

Sisyrinchium: have thin irislike leaves, grow in average to moist garden soil and have open starlike flowers with sharp tipped petals.

Sisyrinchium albiflos—10″ HT, small white notched flowers in summer. 145

Sisyrinchium angustifolium—1.5′ HT, blue flowers with a yellow center in late spring, does well in wet soils. 37, 49, 66, 113, 115, 117, 120, 123, 137, 144, 157

Sisyrinchium atlanticum—similar to *S. angustifolium*, but leaves are pale green. 181

Sisyrinchium bellum—1′ HT, amethyst-violet flowers with purple veins in late spring, short leaves. 5, 123

Sisyrinchium bermudiana—2′ HT, violet-blue flowers in late spring, tender. 49, 121

Sisyrinchium californicum (brachypus)—1.5′ HT, golden-yellow flowers in late spring, thick gray-green leaves, tender. 49, 83, 139, 173

Sisyrinchium campestre—1′ HT, small blue or white flowers in late spring. 127

Sisyrinchium idahoense—10″ HT, large violet flowers with a yellow eye in late spring. 173

Sisyrinchium macounii 'Alba'—8″ HT, large pure white flowers in late spring. 3, 145

Sisyrinchium montanum—97

Sisyrinchium mucronatum 'Pole Star'—8″ HT, pure white flowers in late spring, narrow glaucous leaves. 133, 144, 173

Sisyrinchium striatum—1.5′ HT, pale yellow flowers with thin purple markings in summer, gray-green leaves. 165

Solidago altissima—6′ HT, yellow plumes in late summer, coarse lance-shaped leaves, rhizomatous. 117

Solidago 'Baby Sun'—1′ HT, clear yellow plumes in midsummer, narrow dark green leaves. 95

Solidago bicolor—3′ HT, white or cream flowers in late summer, oblong lance-shaped leaves, clump forming. 113

Solidago caesia—3′ HT, yellow flowers in late summer, lance-shaped toothed leaves. 113, 181

Solidago canadensis—4′ HT, yellow flowers in late summer, lance-shaped toothed leaves, rhizomatous. 52, 66

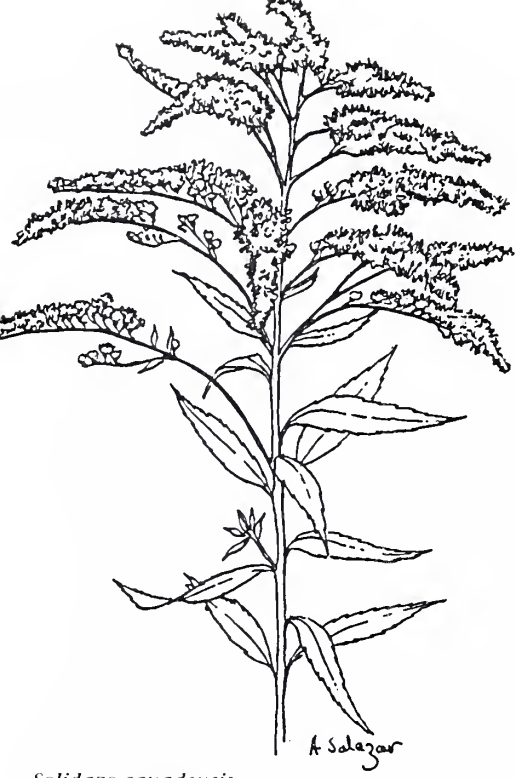
'Golden Baby'—2′ HT, dwarf form. 169

Solidago 'Cloth of Gold'—1.5′ HT, primrose-yellow plumes in midsummer, narrow dark green leaves. 21, 34, 37, 63

Solidago 'Crown of Rays' ('Strahlenkrone')—2′ HT, light yellow flower cluster in midsummer, narrow dark green leaves. 21, 27, 37, 83, 91, 159

Solidago decumbens—1′ HT, mustard-yellow plumes, lance-shaped toothed leaves. 97

Solidago flexicaulis—3′ HT, yellow flowers in late summer, pointed hairy elliptic leaves, rhizomatous. 120



Solidago canadensis

Solidago 'Golden Dwarf'—1′ HT, golden yellow plumes in midsummer, narrow toothed leaves. 65, 83, 153

Solidago 'Golden Mosa'—3′ HT, fluffy yellow flowers in midsummer, narrow chartreuse-green toothed leaves. 21, 37, 65, 91, 153

Solidago hispida—3.5′ HT, yellow plumes, hairy elliptic toothed leaves. 120

Solidago 'Laurin'—1.5′ HT, yellow flowers in late summer. 83, 91, 107

Solidago 'Le Ruft'—2′ HT, bright yellow arching heads in late summer. 34

Solidago microcephala—5′ HT, yellow flower spikes in late summer, very thin grasslike leaves. 117, 181

Solidago nemoralis—3′ HT, yellow arching flower spikes in summer, clump forming, good for dry banks. 113, 115, 117, 120, 127, 157

Solidago odora—4′ HT, yellow plumes in late summer, thin narrow leaves, anise-scented. 113, 115, 117, 157, 173

Solidago 'Peter Pan'—2′ HT, lemon-yellow flower clusters in midsummer, narrow dark green leaves. 49, 95

Solidago pinetorum—4′ HT, yellow arching plumes in midsummer, slender curled leaves. 157

Solidago puberula—3′ HT, yellow wandlike flowers in late summer, elliptic toothed leaves. 117

Solidago rigida—5′ HT, large yellow flowers in flat clusters in late summer, coarse elliptic downy leaves, rhizomatous. 117, 127

Solidago rugosa—6′ HT, yellow arching flower spikes in late summer, coarse crinkled leaves, rhizomatous. 77, 113, 115, 117, 157, 173

Solidago sempervirens—5′ HT, yellow flowers in summer, somewhat succulent oblong lance-shaped leaves, salt tolerant, good for seasides, requires poor sandy soils. 113, 157, 173

Solidago spathulata—2′ HT, sulphur-yellow flower spikes in late summer. 113

nana—5″ HT. 145

Solidago speciosa—3′ HT, yellow wandlike flowers in late summer, narrow leaves on red stems. 113, 117, 127, 157

Solidago stricta—4′ HT, large yellow flower spikes, spatulate leaves, stoloniferous. 173

***Sphaeralcea** angustifolia*—6′ HT, small mauve-to-salmon-to-lavender mallowlike flowers, narrow gray leaves, stoloniferous. 181

Sphaeralcea coccinea—1′ HT, small brownish-red mallowlike flowers in summer, silver feathery leaves. 61

***Stachys** byzantina*—1.5′ HT, mauve-purple flower spikes in summer, oblong pointed white woolly leaves, rhizomatous, requires good drainage in light soils. 9, 21, 29, 49, 65, 69, 75, 83, 91, 98, 107, 117, 139, 144, 153, 159, 175, 177, 183

'Silver Carpet'—more compact habit, does not produce flowers. 9, 27, 37, 49, 65, 91, 97, 153, 159, 169

Stachys grandiflora (macrantha)—1.5′ HT, violet-purple flowers in summer, dark green heart-shaped scalloped leaves. 61, 159

'Superba'—rosy-mauve flowers. 37

Stachys spicata 'Alba'—2′ HT, white flowers. 159

Stachys tennifolia hispida—3.5′ HT, lavender-pink flower spikes in summer, narrow lance-shaped densely hairy leaves, requires moist soils. 120

***Stellaria** holostea*—2′ HT, small white notched flowers in early summer, narrow oblong leaves. 54

***Stokesia** laevis (cyanea)*—2′ HT, blue daisy-like flowers in early summer, leathery gray-green lance-shaped leaves, requires good drainage. 33, 37, 49, 52, 61, 109, 115, 117, 123, 157, 165, 173, 177, 181

'Alba'—white flowers. 181

'Blue Danube'—1′ HT, large medium blue flowers. 9, 37, 49, 65, 77, 91, 122, 137, 153, 159, 165, 169, 171, 175

'Blue Star'—large light blue flowers. 21, 37, 183

'Bluestone'—clear blue flowers. 37

'Silver Moon'—ice-white flowers. 9, 37, 49, 153, 159, 165, 169, 171, 175

'Wyoming'—1′ HT, deep blue to purple flowers. 9, 37, 65, 153, 165

***Stylophorum** diphyllum*—1′ HT, yellow poppylike flowers in late spring, light green hairy lobed leaves, silvery seed pods, self sows. 83, 109, 113, 115, 137, 139, 143, 157, 159, 173

***Succisa** pratensis*—133

***Symphyandra** cretica (Campanula cretica)*—1.5′ HT, blue bellflowers in summer, heart-shaped bristly leaves. 121

Symphyandra hoffmannii - 2′ HT, white hanging bellflowers in summer, coarse oval toothed leaves, requires rich well-drained soils. 121, 159, 161

Symphyandra pendula—2′ HT, small creamy yellow hanging bellflowers in early summer, oblong velvety leaves. 161

Symphyandra wanneri—6″ HT, violet-blue flowers in early summer, hairy lance-shaped toothed leaves, tender. 52, 61

***Symplocarpus** foetidus*—3′ HT, purple-brown flowers mottled with greenish yellow in early spring, lush large oval leaves, requires moist soils. 25, 66, 173

***Tagetes** lucida*—1.5′ HT, small single marigold flowers in summer, toothed anise-scented leaves. 98

***Talinum** calycinum*—6″ HT, fire-red flowers in summer, succulent cylindrical leaves, requires good drainage and sandy soil. 54

Talinum teretifolium—10″ HT, pink flowers with yellow anthers in summer, succulent cylindrical leaves, requires good drainage and sandy soil. 54, 137, 144, 173

***Telekia** speciosa (Buphthalum speciosum)*—6′ HT, fragrant yellow daisies with finely cut petals in summer, oval coarse aromatic leaves, rhizomatous. 49, 52, 83, 91

***Tellima** grandiflora*—1.5′ HT, small yellow-green flower spikes in late spring, basal rounded scalloped evergreen leaves. 49, 52, 65, 83, 109, 139, 153, 159

***Teucrium** aroanium*—2″ HT, purple flowers in summer, small gray woolly rounded leaves in compact tufts, evergreen, requires good drainage. 145

Teucrium canadense—1′ HT, tubular pale rose flowers in midsummer, oval lance-shaped toothed aromatic leaves, semievergreen, rhizomatous. 9, 37, 49, 52, 65, 83, 97, 143, 153, 159, 165, 169

Teucrium chamaedrys—1.5′ HT, rose-pink whorled flowers in midsummer, small oval glossy evergreen leaves. 9, 37, 49, 52, 65, 67, 69, 77, 98, 107, 133, 143, 153, 159, 165, 169, 177, 183

'Prostratum'—1′ HT, prostrate form. 61, 183

'Variegatum'—1.5′ HT, variegated leaves. 49

Teucrium lucidrys—1′ HT, tubular pink flowers in summer, silver-green leaves on upright stems, tender. 61

Teucrium marum—1.5′ HT, purplish spikes in summer, thin lance-shaped tomentose aromatic leaves, tender. 69

Teucrium montanum—1′ HT, tubular clear flowers in late summer, narrow rolled leaves, hairy beneath, on trailing stems. 52

Teucrium scorodonia—10″ HT, pale yellow flower spikes in summer, heart-shaped lime-green crinkled leaves, rhizomatous. 52, 61, 183

'Crispus'—8″ HT, crinkled velvety ruffled leaves. 49, 95, 98, 165

Thalictrum *aquilegifolium*—3′ HT, rich rosy-lilac fluffy flowers in early summer, light green columbinelike leaves, nice pink seed-heads. 9, 34, 37, 49, 54, 65, 91, 95, 107, 139, 143, 144, 153, 161, 165, 175, 177

'Album'—white flowers. 144, 159

'Purpureum'—rich reddish-purple flowers. 27, 29, 159

Thalictrum delavayi—5′ HT, lilac flowers with pale yellow stems in summer, very finely divided blue-green leaves. 9, 37, 159

'Hewitt's Double'—double pure lilac flowers, no stamens. 9, 29, 37, 83, 107, 143, 159

Thalictrum dipterocarpum—very similar to *T. delavayi*, but smaller flowers. 61, 107, 139, 143, 144, 161, 165, 169, 175, 177

Thalictrum flavum—3.5′ HT, yellow feathery flower heads in summer, blue-green columbinelike leaves. 61

Thalictrum kiusianum—6″ HT, purplish-pink flowers with bluish stamens, purplish green divided leaves, stoloniferous. 49, 54

Thalictrum minus (adiantifolium)—3′ HT, greenish-yellow flowers in summer, fernlike leaves. 37, 61, 65, 95, 137, 139, 143, 153, 159, 161, 165

lypoleucum—yellowish flowers. 173

saxatile—3

Thalictrum polygamum—6′ HT, white panicles of flowers in midsummer, finely divided leaves, requires moist to wet soils. 21, 66, 117, 120, 139, 173

Thalictrum rochebrunianum—5′ HT, hanging lavender flowers with yellow stamens in summer, columbinelike foliage. 9, 34, 37, 49, 95, 173

'Lavender Mist'—true lavender flowers. 77, 143, 159

'Purple Mist'—139

Thalictrum speciosissimum (glaucum)—5′ HT, lemon-yellow fluffy flowers, glaucous blue-green divided leaves, prefers moist soils. 9, 29, 49, 95, 139, 143, 159, 161, 177

Thermopsis *caroliniana (villosa)*—5′ HT, spikes of sulphur-yellow pea flowers in early summer, light green pubescent leaves. 9, 37, 39, 49, 66, 77, 113, 153, 157, 159, 165, 177

Thermopsis divaricarpa—97

Thermopsis fabacea—3′ HT, yellow flower spikes in early summer, oval leaves. 52

Thermopsis lupinoides—1′ HT, pale yellow flowers in late spring, oval leaves in threes. 109, 165

Thermopsis montana—2.5′ HT, yellow flowers in early summer, oval leaves in threes, rhizomatous. 65, 77, 153, 159

Thlaspi *alpestre*—1′ HT, white fragrant flowers tinged with red in spring, shiny rosettes of mat-forming leaves, short-lived perennial. 161

Thymus 'Bressingham Pink'—prostrate habit, clear pink flowers in early summer, compact mounded habit. 37, 49, 183

Thymus broussonetii—1′ HT, rose-red flowers in summer, oval leaves on upright stems, pine-scented. 98

Thymus caespititius—3″ HT, rose-pink flowers in summer, narrow leaves in dense tufts, tender. 98, 145, 183

Thymus cilicicus—3″ HT, rose-pink flowers in oval clusters in summer, tufted gray-green hairy leaves, tender. 145

Thymus dzevanorski—prostrate pink fragrant flowers in summer, gray-green leaves. 133, 137

Thymus glabrescens—6″ HT, purple flowers in summer, larger oval leaves. 69

Thymus 'Golden Dwarf'—prostrate habit, golden-yellow leaves. 83, 95

Thymus hyemalis—1′ HT, deep rose flowers in early summer, thin lance-shaped hairy leaves. 183

Thymus mastichina—1′ HT, greenish white flowers in summer, hairy whitish leaves. 11, 69

Thymus pseudolanuginosus—prostrate habit, pink flowers in summer, tiny gray woolly leaves on creeping stems. 3, 9, 21, 29, 37, 63, 65, 69, 83, 91, 95, 97, 107, 121, 133, 137, 144, 153, 159, 169

'Hall's Variety'—pink flowers with purple buds. 37, 159, 183

Thymus pulegioides—3″ HT, mauve flowers in summer, dark green oval leaves. 145

'Albus'—white flowers. 83

Thymus 'Reiter Thyme'—3″ HT, insignificant flowers, rich green leaves on thick mat-forming stems. 145

Thymus richardii (nitidus) 'Peter Davis'—5″ HT, lilac flowers, oval gray leaves. 34

Thymus thracicus (lanicaulis)—4″ HT, lavender flowers in late spring, small gray furry leaves on creeping stems. 37, 98, 183

Townsendia parryi—8″ HT, large purple daisies with yellow centers in spring, basal spatulate leaves, requires dryness in summer. 11

Trachystemon asiaticum (orientale)—1.5′ HT, small purple and blue spikes before leaves appear in spring, large coarse heart-shaped hairy leaves, rhizomatous, invasive. 91

Tradescantia x *andersoniana (virginiana)*—2′ HT, mixed flowers in summer, long narrow cylindrical leaves with purple veins, rhizomatous. 33, 66, 91, 117, 165, 175

'Alpha Major'—large white flowers. 29

'Bilberry Ice'—15″ HT, white flowers tinted with violet. 34

'Blue Stone'—rich medium blue flowers. 9, 37, 65, 143, 153, 159, 165, 177

'Innocence'—pure white flowers. 3, 29, 37, 143, 159, 165, 171

'Iris Pritchard'—white flowers tinted soft blue. 29, 63, 65, 77, 95, 153, 165, 177

'James C. Weguelin'—sky-blue flowers. 3, 9, 29, 34, 37, 65, 77, 83, 137, 153

'Leonora'—violet-blue flowers. 29

'Osprey'—white flowers tinted blue. 3, 29, 83, 107, 143

'Pauline'—orchid-pink flowers. 3, 39, 37, 49, 65, 95, 143, 153, 169, 177

'Purple Dome'—rich purple flowers. 9, 29, 37, 49, 63, 65, 95, 143, 153, 165

'Red Cloud'—maroon flowers, deep green narrow leaves. 3, 9, 29, 37, 39, 65, 77, 95, 107, 137, 144, 153, 159, 165, 169

'Rubra'—red flowers. 9, 83, 143

'Snowcap'—large snow-white flowers. 9, 29, 37, 49, 65, 77, 95, 117, 143, 153, 165, 169, 177

'Valor'—deep red-purple flowers. 9, 83

'Zwanenburg'—large rich purple-tinted blue flowers. 9, 29, 37, 83, 143, 169, 171, 177

Tradescantia bracteata—1.5′ HT, sticky rose flowers, narrow lance-shaped bright yellow-green leaves, rhizomatous. 11

'Alba'—white flowers. 181

Tradescantia hirsuticaulis—1′ HT, brilliant deep violet flowers with yellow anthers in late spring, hairy narrow pointed leaves, clump-forming. 173, 181

Tradescantia longipes—9″ HT, dark dusty rose-blue flowers in late spring, requires sandy soils with some moisture. 145

Tradescantia occidentalis 'Native Blue'—2′ HT, blue flowers in summer, thin lance-shaped glaucous leaves. 97

Tradescantia ohiensis—2′ HT, blue to purple flowers in summer, leaves similar to *T.* x. *andersoniana*, but gray, clump forming. 37, 127, 173

Trifolium repens 'Atropurpureum'—prostrate habit, tiny four-leaved clover leaves of deep maroon with green margins, creeping stems. 98, 133

Trollius: require moist to wet humus-rich soils, have buttercuplike flowers and leaves which are palmately lobed and divided.

Trollius acaulis—6″ HT, lemon-yellow flowers in spring. 3

Trollius 'Canarybird'—canary-yellow flowers. 29, 83, 107

Trollius chinensis (ledebourii)—3′ HT, golden-yellow globe-shaped flowers in early summer. 9, 139, 161, 177

'Golden Queen' ('Goldquelle')—orange flowers. 3, 9, 29, 37, 39, 49, 61, 65, 77, 83, 107, 122, 133, 143, 153, 159, 161, 165, 169, 171

Trollius 'Earliest of All'—orange-yellow flowers. 9, 29, 83

Trollius europaeus—2′ HT, cool lemon-yellow globe-shaped flowers in spring. 9, 29, 65, 139, 153, 159, 161

'Superbus'—larger flowers. 9, 29, 171

Trollius 'Excelsior'—bright yellow flowers. 95

Trollius 'Fireglobe'—large orange flowers.

Trollius 'Goliath'—dark orange flowers. 39

Trollius 'Golden Monarch'—large medium flowers. 107

Trollius laxus—2′ HT, greenish-yellow flowers in early spring. 11

laxus—pale yellow flowers. 173

Trollius 'Lemon Queen'—lemon-yellow flowers. 37, 77, 83, 143

Trollius 'Miss Mary Russell'—lemon-yellow flowers. 9

Trollius 'Moonglow'—soft yellow waxlike flowers. 95

Trollius 'New Hybrids'—mixed flowers. 159

Trollius 'Orange Crest'—orange flowers. 83

Trollius 'Orange Globe'—orange flowers. 161, 165

Trollius 'Orange Princess'—orange flowers. 83

Trollius pumilus—1′ HT, small yellow buttercups in spring. 159

Tropaeolum *polyphyllum*—4′ trailing stems, yellow flowers in early summer, blue-gray smooth deeply lobed leaves, requires well-drained soils. 171

Valeriana *arizonica*—1′ HT, whitish-pink flowers in late spring, oval divided leaves. 61, 137

Verbascum: require good drainage, produce flower spikes and are short lived.

Verbascum blattaria—4′ HT, white or yellow flowers with woolly stamens in early summer, lance-shaped toothed basal leaves. 49, 113, 115, 157

Verbascum bombyciferum—6′ HT, yellow flowers. 52

'Silver Lining' ('Polar Summer')—the entire plant is white woolly tomentose. 159

Verbascum chaixii—4′ HT, yellow flowers with reddish purple stamens in early summer, basal large oval gray-green leaves. 39, 52, 65, 107, 153, 159

'Album'—white flowers with purplish woolly stamens. 37, 49, 52, 65, 153, 159, 171

Verbascum 'Cotswold Gem'—4′ HT, bronze-yellow flowers with purple woolly stamens in summer, large oval gray-green wrinkled leaves. 65

Verbascum 'Letitia'—1′ HT, bright yellow flowers, velvety blue leaves. 145

Verbascum olympicum—5′ HT, bright yellow flowers with white woolly centers, large white hairy leaves. 52, 91, 159, 161, 175, 183

Verbascum phlomoides—6′ HT, yellow flowers with white centers, large basal oblong toothed feltlike leaves. 113

Verbascum phoeniceum—4′ HT, pink, white and purple flowers in late spring, oval basal shiny dark green leaves. 65, 153, 159, 161

'Benary's Hybrid'—mixed flowers. 183

Verbascum 'Pink Domino'—4′ HT, rose-pink flowers with pink centers, large oval wrinkled gray-green leaves. 29, 39, 153

Verbascum 'Silver Candelabra'—6′ HT, yellow flowers. 159

Verbascum thapsus—6′ HT, similar to *V. phlomoides* but with a smaller spikes. 113

Verbascum wiedemannianum—3′ HT, blue to purple lilac flowers with purple woolly centers, basal large toothed white woolly leaves. 49

Verbena bonariensis—6′ HT, bright violet flowers in small tight clusters in midsummer, narrow dark green leaves on upright stems, tender. 34, 37, 95, 109, 161

Verbena canadensis—4″ HT, lilac-rose flowers all summer, short narrow toothed leaves on trailing stems. 37, 95, 97, 109, 133, 137, 153, 171

'Glowing Violet'—brilliant violet-purple. 37, 95, 153

'Rosea'—rose-red flowers. 144

'Rubra'—deep pink flowers. 144

'Sir John'—9

Verbena rigida (venosa)—2′ HT, purple-magenta flowers in short rounded clusters, narrow toothed leaves on stiff stems, tender. 63, 115, 117, 153

'Flame'—brilliant scarlet flowers. 65, 95, 153, 159, 171

Verbena 'Sissinghurst'—144

Verbena tenera maonettii—5″ HT, reddish-violet flowers with white margins in summer, hairy dissected leaves. 34

Vernonia: have thistlelike heads of pink or purple flowers, bloom in late summer and require good moist soil.

Vernonia acaulis—3′ HT, pink and purple flowers, basal rosette of leaves. 173

Vernonia altissima—7′ HT, purple flowers, long lance-shaped leaves. 113, 115, 157

Vernonia fasciculata—5′ HT, reddish-purple flowers, narrow toothed leaves. 127

Vernonia glabra—5′ HT, similar to *V. noveboracensis* but more slender and tolerates dry soil. 173

Vernonia noveboracensis—6′ HT, purple flowers, lanceolate toothed leaves. 66, 157, 159, 173

Veronica: require good well-drained soils, produce flower spikes and bloom in summer.

Veronica allionii—1′ HT, violet flowers, dark green leaves on trailing mats. 54, 97

Veronica alpina 'Alba'—8″ HT, white flowers on creeping stems. 37, 49, 65, 153, 177

Veronica aphylla—3″ HT, large lilac-blue flowers with pink veins on creeping stems. 133

Veronica armena—4″ HT, large bright blue flowers, gray-green dissected leaves on tangled trailing mats. 5, 95, 98, 145

Veronica 'Blue Amethyst'—1′ HT, gentian-blue flowers, narrow toothed leaves. 9, 27

Veronica 'Blue Charm'—1.5′ HT, blue flowers on stout stems, dark glossy green leaves. 29, 65, 133, 169, 171

Veronica 'Blue Giant'—1.5′ HT, deep china-blue flowers in summer, narrow leaves. 95

Veronica 'Blue Wonder'—1.5′ HT, navy-blue flowers in early summer. 65

Veronica 'Blue Sheen'—1′ HT. 83

Veronica bombycina—2″ HT, china-blue flowers in summer, tiny intense silver leaves, requires good drainage. 145

Veronica 'Corymbosa'—1′ HT, deep violet flowers in summer, rich green oval leaves. 37, 133

Veronica 'Crater Lake Blue'—1.5′ HT, gentian-blue flowers. 9, 21, 29, 37, 39, 49, 61, 63, 65, 77, 83, 95, 107, 122, 143, 153, 159, 165, 171, 177, 183

Veronica filiformis—2″ HT, pale blue flowers during early summer, stolonferous, invasive. 83

'Birdseye'—white center in flower. 97

Veronica fruticans (saxatilis)—6″ HT, blue flowers with a reddish-purple center, small oval leaves. 3, 121

Veronica fruticulosa—6″ HT, blue or pale pink flowers. 3

Veronica gentianoides—1.5′ HT, pale blue flowers with dark veins in early summer, basal rosettes of oblong lance-shaped leaves. 83

Veronica grandis holophylla 'Lavender Charm'—1.5′ HT, lavender-blue flowers. 9, 37, 153, 165

Veronica 'Heidekind'—8″ HT, rose-pink flowers. 37, 65, 83, 153, 159

Veronica incana—lilac-blue-to-purple flowers, silver-gray narrow leaves. 3, 9, 21, 33, 37, 39, 49, 52, 65, 83, 97, 107, 109, 133, 137, 153, 159, 165, 183

Veronica latifolia (teucrium)—1.5′ HT, deep blue flowers in late spring, small oval leaves. 109

'Blue Waves'—8″ HT, blue flowers. 21

'Rosea'—1′ HT, pink flowers. 49

'Royal Blue' ('Konigsblau')—1′ HT, brilliant sky-blue flowers. 3, 37, 49, 52, 83, 143, 159, 161, 165, 169, 175, 183

'Sarabande'—bright deep violet flowers, gray-green leaves. 37, 109

'Shirley Blue'—1′ HT, deep blue flowers. 37, 61, 83, 159

Veronica liwanensis—2″ HT, blue erect clusters of flowers in late spring, glossy mounds of leaves on creeping stems. 145

Veronica longifolia—4′ HT, lilac-blue flowers on spikes, lanceolate toothed leaves. 83

'Foerster's Blue'—2′ HT, dark blue flowers. 159

'Small Town'—2.5′ HT, medium blue flowers. 183

subsessilis—2′ HT, violet-blue flowers in erect dense spikes. 21, 37, 65, 153, 159

Veronica 'Minuet'—1′ HT, soft pink flowers in early summer, narrow gray-green leaves. 9, 21, 27, 37, 49, 83, 95, 107, 109, 133, 137, 143, 153, 159, 165, 169, 183

Veronica officinalis—1′ HT, pale blue flowers in late spring, oblong toothed leaves on creeping stems. 69

Veronica orientalis—1″ HT, indigo blue flowers, tiny silver leaves on creeping stems, requires good drainage. 133

Veronica 'Pavane'—1.5′ HT, bright pink flowers, dark green leaves. 21, 25, 37, 95

Veronica pectinata—a mat-forming plant, pink flowers with white centers, white pubescent leaves. 54, 95, 97

'Rosea'—rose-pink flowers. 49, 95, 133, 159

Veronica prostrata (rupestris)—8″ HT, deep blue flowers in late spring, narrow oval deep green leaves, tufted mats of foliage. 9, 21, 145

'Alba'—white flowers. 37, 133, 145

'Heavenly Blue'—sapphire-blue flowers. 37, 65, 83, 95, 133, 137, 143, 153, 159, 165, 169, 177, 183

'Mrs. Holt'—rose-pink flowers. 37, 49, 65, 95, 133, 153

'Purpurea'—3″ HT, purple-blue flowers. 95, 98

'Rosea'—rose-pink flowers. 77

'Trehanii'—6″ HT, bright blue flowers, golden-green leaves. 49, 65, 153, 165

Veronica repens—2″ HT, slender spikes of pale or lavender-blue flowers in spring, oval emerald-green leaves. 3, 33, 52, 95, 97, 159, 161, 175

Veronica 'Romilley Purple'—15″ HT, dark purple flowers in summer, narrow green leaves. 37, 83

Veronica spicata—1.5′ HT, bright blue flowers. 3, 33, 52, 159, 161, 183

'Alba'—white flowers. 159

'Barcarolle'—deep rose-pink flowers. 37, 65, 153, 159, 177

'Blue Fox'—bright deep blue flowers. 37, 65, 133, 153, 165, 183

'Blue Peter'—deep blue flowers. 9, 37, 107, 153, 177

'Blue Spires'—deep violet-blue flowers. 144

'Icicle'—pure white flowers. 9, 21, 29, 37, 63, 65, 77, 83, 95, 107, 143, 153, 159, 165, 169, 171, 177, 183

'Nana'—6″ HT, dwarf form. 9, 37

'Red Fox'—1.5′ HT, reddish-pink flowers. 9, 21, 37, 63, 65, 77, 83, 95, 107, 133, 143, 153, 159, 165, 169, 171, 177, 183

'Red Varieties'—mixed pink and red flowers. 161

'Rosea'—vivid pink flowers. 97, 107, 115, 144, 161

'Royal Blue'—deep blue flowers. 157

'Snow White'—pure white flowers. 49, 65, 153

Veronica 'Sunny Border Blue'—2′ HT, navy-blue flowers, oval toothed leaves on bushy upright stems. 21, 29, 37, 49, 65, 77, 153, 159, 169

Veronica 'Waterperry'—5″ HT, purple-blue flowers, bronze leaves. 109

Veronica wormskjoldii—1′ HT, dark blue flowers, oval leaves, rhizomatous. 3

Veronicastrum japonicum—3′ HT, white flowers. 159

Veronicastrum sibiricum—3′ HT, pink flowers. 159

Veronicastrum virginicum (Veronica virginica)—6′ HT, white flowers in midsummer, dark green narrow whorled leaves on stiff vertical stems, rhizomatous. 37, 49, 69, 117, 123, 127, 159, 173

'Album'—white flowers. 29, 34, 65, 83, 153, 171

'Album Roseum'—pink flowers. 52, 159

'Roseum'—lilac-pink flowers. 49

Viola: prefer cool moist humus-rich soil, bloom in spring and have heart-shaped leaves.

Viola adunca—3″ HT, light purple flowers. 5, 120, 145

Viola alpina 'White Butterflies'—3″ HT, white flowers. 133

Viola beckwithii—3″ HT, bicolor deep purple-blue and white flowers, dissected leaves, rhizomatous, requires dry summer and fall. 145

Viola 'Beshlie'—8″ HT, pale yellow fragrant flowers. 95

Viola blanda—2″ HT, small white fragrant flowers with purple veining, stolonferous. 37, 66, 120, 139

Viola 'Confederate'—8″ HT, bicolor gray-blue and white flowers. 21

Viola conspersa—6″ HT, violet flowers striped with deep purple. 120

Viola cornuta—6-12″ HT.

'Admiration'—dark blue flowers. 107

'Arkwright Ruby'—deep bronze-red flowers with yellow eyes. 21, 97, 107, 159, 177

'Blue Beauty'—purple-blue flowers. 3

'Blue Perfection'—pale blue flowers. 21, 75, 97, 107, 159

'Chantreyland'—fragrant apricot flowers. 21, 39, 97, 107, 159, 177

'Jersey Gem'—purple flowers. 83, 107, 153, 159, 177

'Jersey Gem Alba'—white flowers. 153

'Lord Nelson'—deep violet flowers. 159, 171

'Princess Blue'—velvety-blue flowers. 27

'Scottish Yellow'—lemon-yellow flowers. 97, 159, 171

'White'—white flowers. 39

'White Perfection'—pure white flowers. 21, 97, 107, 159, 177

'Yellow Perfection'—yellow flowers. 21, 107

Viola corsica—6″ HT, violet-blue flowers, very heat tolerant. 109

Viola cucullata—6″ HT, pale violet flowers with darker veins, rhizomatous. 65, 66

'Blue Marsh'—blue flowers. 139

'Freckles'—large white flowers dotted blue. 37, 65, 95, 143, 153, 159, 169, 171

'Gloriole'—waxy white flowers with sky blue centers. 95

'Nancy's Find'—blue flowers striped white. 133

'Priceana'—deep blue flowers with creamy yellow eyes. 153, 171

'Red Giant'—large deep red flowers. 29, 37, 65, 83, 95, 137, 139, 143, 153, 171

'Royal Robe'—fragrant dark violet-blue flowers. 9, 34, 37, 63, 65, 83, 95, 98, 139, 143, 153, 159, 169, 171, 177

'White Czar'—pure white flowers. 3, 9, 29, 37, 83, 98, 122, 139, 143, 153, 159, 169, 171, 177

Viola cuneata—5″ HT, bicolor purple and blue flowers. 145

Viola dissecta chaerophylloides—4″ HT, white flowers marked with blue. 98

sieboldiana—8″ HT, white flowers. 139, 173

Viola 'Duchesse de Parme'—fragrant double soft lavender flowers, tender. 34, 95, 98

Viola 'Eileen'—8″ HT, large deep royal-blue flowers. 95

Viola 'Enchantress'—8″ HT, bright lavender blue flowers. 95, 133

Viola fimbriatula—6″ HT, violet flowers with deep blue stripes. 173

Viola glabella—10″ HT, yellow flowers with purple veins. 37

Viola hallii—3″ HT, bicolor flowers of deep blue and cream, palmately divided leaves. 145

Viola hastata—10″ HT, yellow-tinged violet flowers, arrow-shaped leaves. 66

Viola hederacea—5″ HT, bicolor flowers of blue and white on trailing rooting stems, stoloniferous, tender. 95, 109

Viola 'Irish Molly'—8″ HT, bright yellow flowers with bronze centers. 34

Viola jooii—4″ HT, pinkish-lilac fragrant flowers. 133

Viola labradorica—5″ HT, purple flowers, heart-shaped purple leaves. 3, 34, 37, 49, 61, 77, 95, 98, 159, 171

Viola lanceolata—10″ HT, white flowers with red veins, narrow lanceolate leaves. 173

Viola lutea 'Splendens'—10″ HT, bright yellow flowers. 39, 83, 107, 177

Viola macloskeyi pallens—6″ HT, white flowers, stoloniferous. 120

Viola 'Maggie Mott'—8″ HT, fragrant pale blue flowers with cream centers. 95

Viola 'Marie Louise'—fragrant deep violet flowers with red centers. 34, 98

Viola Mt. Spokane'—8″ HT, fragrant snow white flowers with blue blush. 95

Viola 'Nellie Britten'—8″ HT, soft lavender-blue flowers. 34

Viola odorata—10″ HT, fragrant deep violet flowers, stoloniferous. 3, 5, 52, 98, 139

'Alba'—white flowers. 95

'Charles William Groves'—warm magenta flowers with purple reverse. 34

'Coeur D'Alsace'—rosy-salmon flowers. 34

'Fair Oaks'—rose-mauve flowers. 34

'Governor Herrick'—large dark violet-blue flowers. 34

'John Raddenbury'—blue flowers. 34

'Lady Hume Campbell'—double blue flowers. 98

'Lambs White'—white flowers. 34

'Lianne'—large dark-purple flowers. 139

'Mme. Armandine Pages'—rose-red flowers. 34

'Princess of Wales'—soft lavender-blue flowers. 34

'Red Queen'—bright rose-pink flowers. 34

'Rosea'—soft pink flowers. 98

'Rosina'—bright deep pink flowers. 37, 77, 95, 109, 133, 153, 173, 181

'Royal Blue'—deep blue flowers. 165

'Semperflorens'—royal-blue flowers. 95, 133

'White Queen'—white flowers. 9

Viola palmata—8″ HT, pale blue flowers, palmately lobed leaves. 21, 37, 173

Viola pedata—6″ HT, lilac flowers, requires well-drained sandy soil. 25, 29, 37, 49, 66, 83, 109, 137, 145, 157, 159, 171, 173

'Bicolor'—bicolor form. 37, 66, 133, 139, 145

'Eco Snow White'—white flowers. 54

'Eco Summer Sky'—white flowers shaded lavender. 54

Viola primulifolia—10″ HT, white flowers with prominent purple veins. 21, 173

Viola rafinesquii—6″ HT, violet-edged flowers with cream centers. 107

Viola reichenbachiana 'Rosea' *(sylvestris)*—pink flowers. 95

Viola renifolia—white flowers with brown veins, kidney-shaped leaves. 120

Viola rupestris—4″ HT. *glaberrima*—pink flowers. 98

'Rosea'—pale pink flowers. 37

Viola sagittata—6″ HT, violet flowers with darker veins and white centers, lance-shaped toothed leaves. 66, 117

Viola selkirkii—4″ HT, pale violet flowers. 109, 120

Viola septemloba—6″ HT, rich violet-blue flowers, deeply cut leaves. 95, 137, 153

Viola 'Snow Princess'—6″ HT, snow-white flowers. 95

Viola sororia (papilionacea)—6″ HT, deep violet flowers with white throats. 37, 65, 83, 95, 120

'Alice Witter'—white flowers with wine-red centers. 37, 95, 121, 137

Viola striata—1′ HT, white veined blue flowers with pink centers. 37, 139

Viola 'Sylvia Hart'—3″ HT, rose-pink flowers, pale green leaves with silver veins. 145

Viola 'Talitha'—8″ HT, large rich blue-violet flowers with white centers. 34

Viola variegata (koreana)—3″ HT, pink flowers, round mottled leaves. 133, 145

Viola verecunda yakusimana—1″ HT, tiny white flowers with purple veins. 145

Viola vilmoriniana (sulphurea)—6″ HT, apricot-yellow flowers. 95, 133

Viola walteri—8″ HT, violet-blue flowers. 181

Viola 'Windsor'—8″ HT, fragrant silvery blue flowers. 95

Vitaliana *primulaeflora tridentata (Androsace* or *Douglasia vitaliana)*—1″ HT, tubular buttercup-yellow flowers in spring, rosettes of narrow green leaves with silver tips, requires good drainage. 145

Waldsteinia *fragarioides*—6″ HT, yellow flowers, dark green lobed leaves, rhizomatous. 11, 83, 97, 133, 137, 144

'Eco Dense Cover'—dense habit. 54

Waldsteinia geoides—4″ HT, yellow flowers, deep green five-lobed leaves. 83, 91

Waldsteinia ternata (sibirica)—4″ HT, yellow flowers, evergreen shiny deep green three-lobed leaves. 3, 21, 37, 49, 67, 83, 91, 121, 143, 159, 169

Wulfenia *carinthiaca*—2′HT, deep purple tubular flowers on spikes in summer, rosettes of thick oval scalloped leaves, requires well-drained soil. 52

Xerophyllum *asphodeloides*—5′HT, small white flower clusters in early summer, coarse grasslike basal leaves. 66

Xerophyllum tenax—5′HT, small creamy white flowers with purple stamens in summer, coarse grasslike basal leaves. 145

Yucca *filamentosa*—5′HT, pale greenish-cream bells on stiff branching stems in summer, long narrow gray-green leaves with threadlike hairs on the margins. 3, 9, 65, 66, 83, 91, 107, 121, 137, 144, 153, 159, 169

'Hofer Blue'—2′HT, glaucous leaves. 67

Yucca flaccida—6′HT, cream flowers held horizontally, narrow leaves. 173

'Ivory Tower'—flowers outfacing. 37, 65, 153

Yucca glauca—5′HT, greenish-white bells on spikes in summer, narrow leaves edged with white and gray threads. 9, 37, 83, 91, 133, 159, 169

Yucca smalliana—very similar to *Y. filamentosa*. 37, 41

'Bright Edge'—leaves edged with yellow. 37, 153, 159

Zauschneria *californica*—1.5′HT, small scarlet trumpet flowers in late summer, linear gray-green leaves, rhizomatous, requires excellent drainage. 11

'Alba'—white flowers. 145

'Etteri'—8″ HT, silvery leaves. 95

'Glasnevin'—10″ HT, mat-forming green leaves. 34

latifolia (arizonica)—10″ HT, oval lance-shaped leaves. 61

Solidarity Pink'—large shell-pink flowers. 34, 145

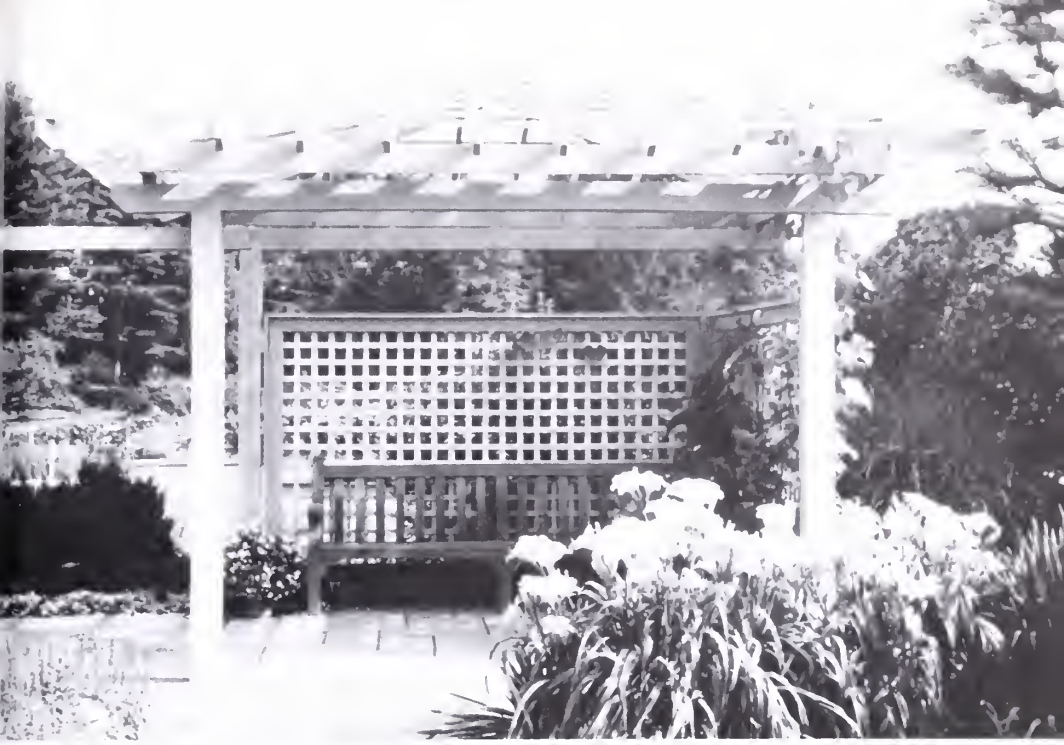
'Splendens'—deep green leaves. 95

Zauschneria cana—2′ HT, scarlet flowers in late summer, tiny narrow gray leaves, rhizomatous, tender. 95

Zauschneria septentrionalis—8″ HT, tubular scarlet flowers in late summer, two toned gray-green leaves. 145

Zinnia *grandiflora*—10″ HT, yellow daisies with red centers in summer, linear hairy leaves, requires good drainage. 97

Zizia *aptera*—10″ HT, yellow flowers in spring of flat-topped clusters, shiny basal green leaves, requires moist humus-rich soil. 173



Perennials for Shade

Aconitum x *bicolor*—4′ HT, white flowers edged with blue in summer. 9, 29, 39, 49, 95, 143, 159

Aconitum carmichaelii (fischeri)—4′ HT, violet-blue flowers in fall. 9, 29, 109, 143, 159

'Arendsii'—dark violet flowers. 3, 29, 83, 143, 159

'Baker's Variety'—5′ HT, amethyst-blue flowers. 143

Aconitum columbianum—5′ HT, deep blue flowers in summer. 61

Aconitum henryi 'Spark's Variety'—4′ HT, dark violet flowers in summer. 29, 37, 95, 159

Aconitum napellus—4′ HT, pale violet flowers in summer. 9, 29, 39, 49, 95, 143, 159, 161, 169

'Album'—pinkish white flowers. 143

'Bressingham Spire'—3′ HT, violet-blue flowers in summer. 9, 29, 109, 143, 159

'Newry Blue'—deep violet-blue flowers. 33, 143, 159

'Rubellum'—3′ HT, pink flowers. 39

Aconitum pyrenaicum—2.5′ HT, yellow flowers in summer. 39, 143

Actaea rubra—1.5′ HT, grown for green foliage and red berries. 37, 139

neglecta—120

Actaea pachypoda (alba)—1.5′ HT, white berries. 9, 25, 37, 66, 120, 139

Adenophora *confusa*—2.5′ HT, deep blue flowers in summer. 39, 49, 165, 177

Adenophora liliifolia—2.5′ HT, pale blue flowers in summer. 9, 49, 159, 165, 169

Adlumia *fungosa*—vine to 10′ HT, pink flowers in summer and fall, ferny soft green foliage, biennial. 109

Adonis *amurensis*—1′ HT, golden-yellow flowers in spring, green dissected foliage. 9, 139, 177

'Pleniflora'—double flowers. 9, 29

Adonis vernalis—171

Aegopodium *podagraria* 'Variegatum'—1′ HT, white flowers in spring, white and green variegated leaves, ground cover, extremely invasive. 3, 33, 37, 49, 67, 69, 75, 95, 117, 143, 159, 165, 169

Ajuga *genevensis*—9″ HT, blue flowers in spring, shiny green leaves, rhizomatous. 37, 49, 95, 159, 169, 183

'Pink Beauty'—6″ HT, light pink flowers. 37, 54, 77, 159, 169, 183

Ajuga 'Purple Brocade'—6″ HT, bright blue flowers in spring, crinkled maroon leaves. 37, 41

Ajuga pyramidalis—6″ HT, royal blue flowers in spring, shiny green leaves, rhizomatous. 9, 49, 95, 109, 177

'Metallica Crispa'—4″ HT, blue flowers in spring, purplish-brown crinkled leaves. 9, 37, 49, 91, 137, 145, 169

'Metallica Crispa Nana'—dwarf from of above. 165

'Nana Compacta'—4″ HT, blue flowers in spring, dark green crinkled leaves. 49, 169

Ajuga reptans—6″ HT, blue flowers in spring, shiny green leaves, stoloniferous. 41, 91, 120, 165

'Alba'—white flowers. 9, 37, 49, 77, 91, 95, 109, 177

'Argentea'—blue flowers in spring, silver leaves. 49

'Atropurpurea'—dark purple flowers in spring, bronze-purple leaves. 3, 75, 91

'Brockbanki'—83

'Bronze Beauty'—indigo to dark purple flowers. 33, 37, 67, 159, 165, 183

'Burgundy Glow'—blue flowers in spring, leaves burgundy, cream and green. 9, 27, 37, 49, 67, 77, 95, 109, 117, 159, 165, 169, 177, 183

'Delightful'—83

'Metallica'—similar to 'Bronze Beauty' but leaves are larger. 183

'Multicoloris'—leaves mottled with red, white, yellow and green. 98

'Pink Silver'—similar to 'Burgundy Glow' only more vigorous. 37

'Rosea'—rose-pink flowers. 9

'Rubra'—reddish purple flowers. 5

'Variegata' ('Silver Beauty' and 'Grey Lady')—blue flowers, white and green variegated leaves. 37, 49, 91, 95, 159, 165, 183

'Versicolor'—blue flowers, leaves gray edged with white. 3

Ajuga 'Silver Sheen'—6″ HT, blue flowers in spring, leaves green, pink and white. 41

Anemone *hupehensis*—1-3′ HT, rose flowers in fall. 3, 9, 49, 139, 165, 169

'Splendens'—9, 29, 39, 159

'Superba'—37, 91, 159

Anemone x *hybrida (japonica)*—3′ HT, dark green cleft foliage, blooms in fall, requires moist soil. 54, 143

'Alba'—white flowers. 9, 27, 37, 91

'Alice'—double pink flowers. 37

'Avalanche'—65

'Elegans'—91

'Honorine Jobert'—white with yellow center. 9, 29, 91, 165

'Kriemhilde'—pink flowers. 9, 91, 165

'Margarette'—double clear bright pink flowers. 9, 27, 37, 59, 91

'Max Vogel'—9

'Mont Rose'—deep rose flowers. 9, 91

'Praecox'—83

'Prince Henry'—double deep rose flowers. 9, 37, 91

'Queen Charlotte'—semidouble pink flowers. 9, 29, 37, 91

'Richard Ahrends'—semidouble pink flowers. 91, 165

'Rosea Elegans'—83

'Rubra'—83

'September Charm'—deep pink flowers. 9, 29, 37, 77, 91, 165

'Whirlwind'—semidouble white flowers. 9, 27, 37, 91, 165

Anemone x *lesseri*—1.5′ HT, deep rose-carmine flowers in summer. 3, 49, 133, 159

Anemone magellanica—18″ HT, white flowers in summer. 61, 139, 159, 177

Anemone sylvestris—1.5′ HT, white flowers in spring, cleft green foliage. 3, 29, 37, 49, 61, 95, 133, 143, 145, 159, 165, 169

Anemone virginiana—2.5′ HT, greenish white flowers in summer, cleft foliage. 25, 61, 113, 115, 120, 181

Anemone vitifolia (tomentosa) 'Robustissima'—3′ HT, clear pink flowers in late summer and fall, cleft green foliage. 9, 29, 37, 39, 49, 91, 95, 109, 139, 143, 159, 165

Anemonella *thalictroides*—10″ HT, white or pinkish flowers in spring, blue-green columbinelike leaves, requires moist soil. 37, 49, 54, 109, 139, 145, 157, 173

'Alba'—10″ HT, pure white form. 29, 145

'Cameo'—8″ HT, double pastel flower. 54

'Double White'—8″ HT, double white flowers. 145

'Georgia Whites'—8″ HT, single white. 54

'Pink'—8″ HT, pink flowers. 145

'Rosea'—8″ HT, single pink flowers. 29

'Schoaf's Double Pink'—8″ HT, double pink flowers. 29

'Wisconsin Pinks'—10″ HT, pink shades of flowers. 54

Anemonopsis *macrophylla*—2′ HT, lavender-blue flowers in summer, large ferny leaves, grown for foliage, needs cool moist soil. 145

Aplectrum *hyemale*—2′ HT, greenish brown flowers in spring, evergreen. 66

Aquilegia *alpina*—1.5′ HT, violet-blue flowers in late spring, fernlike foliage. 3, 5, 159, 161, 165

'Superba'—83

Aquilegia aurea—1′ HT, sulphur-yellow flowers in late spring, fernlike gray foliage. 173

Aquilegia barnabyii—1′ HT, orange-yellow flowers in late spring, fernlike green foliage. 139

Aquilegia bertolonii—6″ HT, blue and white flowers in late spring, fernlike green foliage. 133, 145

Aquilegia buergerana—2′ HT, pale yellow flowers in late spring. 109

Aquilegia 'Bluebird'—97

Aquilegia caerulea—2′ HT, blue and white flowers in late spring, gray-green foliage. 9, 77, 91, 133, 137, 143, 161, 173, 175, 177

'Biedermeier'—1′ HT, white, pink and purple flowers in late spring. 27, 39, 133, 137, 145, 159, 161, 169, 183

'Black Star'—3′ HT, dark purple flowers. 159

'Blue Shades'—2′ HT, blue flowers. 39, 161, 169

'Blue Star'—3′ HT, blue and white flowers. 159

'Blue Tone'—blue flowers. 52

'Crystal'—2′ HT, pure white flowers. 161

'Dragonfly Hybrids'—1.5′ HT, mixed flowers of red, pink, white, yellow and blue. 133, 159, 161, 169, 177

'Fairyland'—2′ HT, flowers face upwards, mixed colors. 133, 159

'Heavenly Blue'—2′ HT. 161

'Mrs. Scott Elliot'—3′ HT, mixed colors. 159, 161

'Olympica'—2′ HT, blue flowers. 9

Aquilegia 'Cardinal'—97

Aquilegia chaplinei—49

Aquilegia chrysantha—2.5′ HT, golden-yellow long spurred flowers in late spring. 5, 39, 49, 161, 173, 177

'Silver Queen'—2.5′ HT, white flowers. 177

'Yellow Queen'—2.5′ HT, yellow flowers. 159

Aquilegia discolor—1′ HT, blue and white flowers. 109, 145, 173

Aquilegia ecalcarata—49

Aquilegia einseleana—18″ HT, violet-blue flowers. 121

Aquilegia elegantula—4″ HT, red/yellow flowers. 133

Aquilegia flabellata (akitensis)—18″ HT, blue flowers in early spring.

'Alba'—white flowers. 137, 143, 169, 173

'Mini Star'—6″ HT, bright blue flowers. 3, 49, 143, 159, 161

'Nana'—6″ HT, 5, 9, 37, 49, 77, 137

'Nana Alba'—6″ HT, white fragrant flowers. 9, 37, 95, 159, 177

pumila—6″ HT, blue and lilac/cream flowers. 9, 173

Aquilegia formosa—2″ HT, red and yellow flowers. 3, 5, 49, 61, 139, 173

Aquilegia fragrans—1.5′ HT, creamy white fragrant flowers, gray-green leaves. 34

Aquilegia glandulosa—2′ HT, blue to purple flowers. 173

jucunda—blue to white flowers. 9, 95

Aquilegia 'Gold Finch'—97

Aquilegia 'Harmony'—1.5′ HT. 109

Aquilegia x 'Hensol Harebell'—3′ HT, deep bluish purple flowers. 34, 49, 95, 177

Aquilegia x *hybrida*

'Crimson Star'—2′ HT, red and white flowers. 39, 49, 139, 143, 159, 161, 165, 169, 177

'Dynasty'—1.5′ HT, mixed colors. 49

'Dynasty White'—white flowers. 175

'Dynasty Yellow'—yellow flowers. 175

Aquilegia 'Jane's White'—white version of 'Hensol Harebell'. 177

Aquilegia kitaibelii—1′ HT, red-violet to blue-violet flowers. 143, 173

Aquilegia 'Kristall'—2.5′ HT, pure white flowers. 159

Aquilegia 'Langdon's Rainbow Hybrids'—2.5′ HT, mix of bright colors. 177

Aquilegia longissima 'Maxistar'—2.5′ HT, clear yellow, long spurred flowers. 159, 161, 177

Aquilegia 'McKana's Giants'—2.5′ HT, mixed colors, long spurred flowers. 5, 9, 27, 67, 75, 137, 157, 159, 165, 169

Aquilegia 'Miniature Bluebird'—97

Aquilegia 'Music Mix'—1.5′ HT, long spurred, mixed flowers. 161, 169, 175, 183

Aquilegia 'Nora Barlow'—2′ HT, double red, pink and green flowers. 34, 77, 95, 157, 159, 165, 169, 177

Aquilegia olympica—2′ HT, violet to white flowers. 'Alba'—white flowers. 173

'Georgia'—11

Aquilegia oxysepala—3′ HT, claret to pale yellow flowers. 173

Aquilegia pyrenaica—6″ HT, blue flowers. 95

Aquilegia 'Red Gold Hybrids'—2′ HT, large red to gold flowers. 159

Aquilegia 'Rocky Mountain'—159

Aquilegia 'Rose Queen'—177

Aquilegia saximontana—10″ HT, blue flowers. 61, 97, 133, 145

Aquilegia 'Silver Queen'—2.5′ HT, pure white flowers. 159

Aquilegia 'Spring Song Strain'—122, 177

Aquilegia 'Tanager'—97

Aquilegia vulgaris—3′ HT, blue, purple and white flowers. 3, 49, 97, 161

'Flore Pleno'—double flowers. 3, 65, 153, 159, 161

'Plum Pudding'—double violet flowers. 159

Arisaema *dracontium*—2′ HT, yellow-green flowers in early summer, red berries in fall, divided leaves. 11, 175

Arisaema triphyllum—1′ HT, purplish green flowers in early summer, red berries in fall, three lobed leaf. 9, 25, 29, 37, 49, 66, 75, 113, 120, 143, 157, 173

'Zebrinum'—white stripes on inside of flower. 11

Arum *italicum*—1.5′ HT, greenish white to creamy white flowers in spring, broad shiny leaves in fall, orange berries in summer. 41, 49, 173

'Dr. Comstock'—large berries. 49

Arum maculatum—similar to *A. italicum* but smaller in leaf with purple spots. 11

Aruncus *aethusifolius*—1′ HT, white plumes in late spring, lacy green leaves. 37, 41, 49, 77, 91, 143, 159, 161, 165, 173

Aruncus asiaticus—3′ HT, white flowers. 9

Aruncus chinensis—4′ HT, ivory plumes. 9, 161, 165

Aruncus dioicus (sylvester)—5′ HT, ivory plumes in early summer, lacy green leaves, seed heads remain ornamental for months. 3, 37, 39, 49, 61, 66, 77, 91, 95, 143, 157, 159, 165, 169, 173, 175

'Child of Two Worlds ('Zweiweltenkind')'—4′ HT, plumes more pendulous than species. 9, 37, 133, 159, 165

'Kneiffi'—2.5′ HT, creamy flowers, filigree leaves. 9, 29, 91, 143

Asarum *arifolium (Hexastylis arifolium)*—5″ HT, leaves evergreen, arrow shaped. 41, 121, 173, 181

Asarum canadense—5″ HT, leaves deciduous, heart shaped. 11, 25, 29, 37, 66, 91, 109, 120, 133, 139, 143, 157, 181

'Eco Choice'—5″ HT, larger in leaf than species. 54

Asarum candatum—6″ HT, semievergreen, heart-shaped leaves. 139, 145, 173

Asarum europaeum—5″ HT, shiny evergreen leaves. 9, 29, 37, 49, 67, 81, 91, 98, 133, 139, 159, 169, 173, 177

Asarum hartwegii—5″ HT, evergreen leaves mottled with white. 139, 145

Asarum lemonii—5″ HT, deciduous leaves. 181

Asarum minor—5″ HT, evergreen, leaves mottled along veins. 173

Asarum shuttleworthii (Hexastylis shuttleworthii) 8″ HT, mottled evergreen foliage. 9, 139, 181

Asarum speciosum (Hexastylis speciosum)—181

Asarum virginicum—5″ HT, bright green heart-shaped mottled leaves. 173

Asarum wagneri—4″ HT, light green wavy leaves, lemon scented. 145

Asperula gussonei (suberosa)–1″ HT, hairy gray mat for trough or scree. 145

Aster cordifolius —4′ HT, violet-blue flowers in fall, heart-shaped leaves. 34. 120

Aster divaricatus—3′ HT, white flowers in fall, dark purple stems. 34

Astilbe x *arendsii*—blooms in late spring to early summer, dissected foliage, requires moist soil.

'America'—3′ HT, light pink flowers. 29, 37

'Amethyst'—3.5′ HT, brilliant lilac to violet flowers. 29, 37

'Anita Pfeifer'—2.5′ HT, light pink flowers. 29, 37, 159

'Bergkristal'—2.5′ HT, pure white flowers. 9, 29

'Bonn'—2′ HT, medium pink flowers. 29, 37, 49, 91, 159

'Brautschleier'—2′ HT, white flowers. 91

'Bremen'—2′ HT, deep carmine-rose flowers. 29, 37, 91, 143, 169

'Bressingham Beauty'—3′ HT, rich pink arching plumes. 9, 29, 37, 159, 169

'Bridal Veil'—3′ HT, white flowers. 29, 37, 49, 77, 133, 143, 159, 165, 169

'Cattleya'—3.5′ HT, orchid-pink flowers. 9, 29, 37, 39, 49, 77, 133, 159, 169

'Cologne' ('Koln')—2′ HT, deep salmon-rose flowers. 29, 37, 159

'Color Magic'—mixed colors. 3

'Deutschland'—1.5′ HT, white flowers. 9, 27, 29, 37, 39, 49, 91, 95, 143, 157, 159, 165, 169

'Diamond'—3′ HT, white flowers. 29, 37, 39, 91, 159

'Dusseldorf Pride'—2′ HT, carmine-red flowers. 29, 159

'Emden'—2′ HT, lilac flowers. 29

'Erica'—3′ HT, heather-pink flowers. 9, 29, 37, 49, 91, 159, 169

'Etna'—2.5′ HT, deep red flowers. 37, 91, 143, 169

'Europa'—2′ HT, clear pink flowers. 9, 91, 159

'Fanal'—2.5′ HT, deep red flowers. 9, 27, 29, 37, 77, 91, 133, 143, 157, 159, 169

'Federsee'—2.5′ HT, carmine-rose flowers. 29, 37, 95, 133, 159, 169

'Fire' ('Feuer')—3′ HT, carmine-red flowers. 29, 37, 91

'Gertrude Brix'—2′ HT, dark red flowers. 29, 37, 91

'Gladstone'—2′ HT, white flowers. 29, 49, 91

'Gloria'—2′ HT, deep rose flowers. 91

'Gloria Purpurea'—3′ HT, rose-lavender flowers. 37, 159

'Gloria Rosea'—3′ HT, deep rose flowers. 37, 159

'Glow' ('Glut')—3′ HT, dark red flowers. 29, 37, 49, 77, 91, 95, 143, 159, 169

'Granath'—3′ HT, rose-pink flowers. 29, 37, 91, 159, 165, 169, 177

'Hyacinth'—3′ HT, brilliant pink and lilac flowers. 37

'Intermezzo'—1′ HT, red flowers. 9

'Irrlicht'—2.5′ HT, pale pink changing to white flowers. 9, 29, 37, 91, 159, 169

'Koblenz'—2′ HT, dark pink flowers. 9, 29, 159

'Mainz'—2.5′ HT, deep lilac to lavender pink flowers. 37, 91, 159

'Mars'—2′ HT, dark lilac-rose flowers. 29

'Montgomery'—2.5′ HT, deep red flowers. 9, 29, 37, 91, 159

'Peach Blossom'—2′ HT, light salmon-pink flowers. 9, 27, 29, 37, 39, 49, 77, 91, 143, 159, 165, 169, 177

'Queen Alexandra'—2′ HT, light rose flowers. 29

'Queen of Holland'—2′ HT, white flowers. 29, 169

'Red Light'—1.5′ HT, red flowers. 169

'Red Sentinel'—2.5′ HT, bright red flowers. 9, 29, 37, 39, 91, 159, 169

'Rheinland'—2.5′ HT, clear pink flowers. 27, 29, 37, 39, 49, 95, 157, 159, 165, 169

'Salmon Queen'—2′ HT, salmon flowers. 9

'Serenade'—2′ HT, rose-red flowers. 91

'Spartan'—3′ HT, deep red flowers. 37, 165

'Snowdrift'—2.5′ HT, pure white flowers. 37, 159

'Spinell'—3′ HT, carmine-red flowers. 29, 37, 159, 169

'Venus'—3′ HT, salmon-red flowers. 29, 37, 91

'Washington'—1.5′ HT, white flowers. 29, 159

'White Gloria'—2′ HT, creamy white flowers. 9, 29, 37, 91, 159, 169

Astilbe biternata—6′ HT, white flowers, large ferny leaves. 66, 157

Astilbe chinensis—2′ HT, mauve flowers in mid summer, requires moist soil. 91

'Finale'—1.5′ HT, soft pink flowers. 9, 29, 37, 49

'Intermezzo'—1.5′ HT, salmon-pink flowers. 29, 37, 159

'Pumila'—1′ HT, mauve-pink flowers in late summer. 3, 9, 27, 29, 34, 37, 49, 61, 77, 91, 95, 133, 137, 143, 145, 159, 165, 169, 173

'Serenade'—1′ HT, rose-red flowers. 29, 159

'Veronica Klose'—1.5′ HT, purplish lavender flowers. 9, 29

Astilbe 'Litchfield Lady'—2.5′ HT, dusky rose-pink flowers. 177

Astilbe 'Loie'—1.5′ HT, soft pink flowers. 34

Astilbe 'Purple Candle'—3.5′ HT, purplish red flowers. 9, 29

Astilbe simplicifolia—blooms in mid-to late summer, finely divided leaves.

'Alba'—16″ HT, white flowers. 9

'Aphrodite'—16″ HT, rose-red flowers. 9

'Atrorosea'—1′ HT, deep pink arching plumes. 37, 159

'Inshirach Pink'—1.5′ HT, pink flowers. 9

'Praecox'—1.5′ HT, white flowers, earlier than 'Alba'. 9

'Rosea'—1.5′ HT, light pink flowers. 9, 173, 177

'Sprite'—1′ HT, shell-pink flowers. 9, 173, 177

'William Buchanan'—6″ HT, flesh-pink flowers, glossy bronze foliage. 37

Astilbe 'Tacquetti Superba'—4′ HT, mauve flowers in late summer, dark green hairy ferny foliage, tolerant of more sun and dryer soils than other hybrids. 9, 29, 34, 37, 39, 49, 77, 91, 143, 159, 165, 169, 177

Astilbe thunbergii—pendulous flowers in midsummer. 173

'Betty Couperus'—3.5′ HT, pink flowers. 9, 29

'Ostrich Plume'('Straussenfeder')—3.5′ HT, coral-pink flowers. 9, 29, 34, 37, 77, 91, 95, 159, 177

'Pink Curtsy'—pale rose-pink arching flowers. 34

'Professor Van Der Weilen'—3.5′ HT, white flowers. 9, 29, 159, 177

Astrantia carniolica rubra—1.5′ HT, maroon, silvery pink flowers in summer, requires moist soils. 159

Astrantia major—2.5′ HT, bracts of purple, white or pale pink, lush green leaves. 34, 95, 159, 165

'Mt. Rubra'—107

'Rose Symphony'—2.5′ HT, rose-pink flowers. 161

Astrantia 'Margery Fish'—2.5′ HT, shades of pink and white. 177

Astrantia maxima—2′ HT, strawberry-pink, bold cut leaves. 34

***Begonia** grandis (evansiana)*—2′ HT, blush colored flowers in late summer, large shiny leaves with red tufts beneath. 9, 21, 37, 41, 91, 109, 117, 137, 159, 171, 181

'Alba'—white form of the species. 109, 181

***Bergenia** cordifolia*—15″ HT, magenta flowers in spring, evergreen leaves, will tolerate sun and partial shade. 5, 9, 21, 27, 29, 33, 37, 39, 49, 52, 65, 67, 77, 83, 91, 95, 97, 107, 137, 143, 161, 169, 175, 177, 183

'Abendglut' ('Evening Glow')—9″ HT, crimson and purple semidouble flowers in spring, tufts of round leathery evergreen leaves turning maroon in fall and winter. 9, 29, 37, 83, 91, 159

'Abendglocken' ('Evening Bells')—14″ HT, rose-pink flowers in spring, rounded leathery leaves turning maroon in fall and winter. 9, 29, 91

'Baby Doll'—8″ HT, pink flowers. 34

'Bressingham Salmon'—1′ HT, salmon-pink flowers. 171

'Bressingham White'—29, 37, 133, 143, 159, 169, 171

'Glockenturm' ('Bell Tower')—14″ HT, pinkish red flowers. 29, 83, 91, 143

'Morgenroete' ('Morning Red')—8″ HT, carmine-red flowers, may rebloom in fall. 29, 37, 83, 91, 143, 159, 169

'Perfecta'—10″ HT, pink flowers. 9, 29, 37, 83, 91, 143, 159, 169, 171

'Rotblum' ('Redbloom')—15″ HT, red form of species. 3, 29, 37, 65, 91, 107, 133, 159, 161, 169

'Silberlicht' ('Silver Light')—10″ HT, pinkish white flowers. 9, 29, 37, 39, 49, 83, 143, 159, 169, 171

'Sunningdale'—1′ HT, carmine-red flowers, beet red foliage in autumn. 9, 29, 37, 83

Bergenia crassifolia—1′ HT, magenta flowers in spring, leaves spoon shaped, red fall color. 95

'Orbicularis'—1′ HT, purplish pink flowers. 29

Bergenia purpurascens (delavayi)—1′ HT, rose-pink flowers in spring, beet red fall color. 9, 29, 49, 52, 83, 95, 159, 183

***Bletilla** striata (hyacinthina)*—1.5′ HT, purple flowers in early summer, rich green sword-shaped leaves. 9, 37, 95

'Alba'—white flowers. 9, 37, 145

'Rosea'—deep purple-pink flowers with white markings. 145

***Brunnera** macrophylla*—1.5′ HT, blue flowers in spring, coarse, heart-shaped leaves. 9, 21, 27, 29, 37, 49, 65, 77, 83, 91, 95, 107, 133, 137, 139, 143, 153, 157, 159, 165, 169, 177

'Variegata'—1′ HT, leaves dashed with creamy white. 29

***Buglossoides** purpureocaeruleum (Lithospermum purpurascens caeruleum)*—2′ HT, intense blue flowers in late spring, stems root at tip. 95

***Calypso** bulbosa*—5″ HT, scape to 9″ HT, flower white to purple streaked with red, found in bogs and cool forests. 145

***Campanula** alpina*—10″ HT, lilac-blue flowers in summer, hairy rosettes of leaves, good for screes and troughs. 161

Campanula americana—4′ HT, rich blue-violet flowers, long narrow leaves, requires moist soils, biennial. 157

Campanula isophylla—trailing plant with blue flowers, good for hanging baskets, small heart-shaped leaves.

'Alba'—white flowers. 95

'Caerulea'—blue flowers. 95

Caulophyllum *thalictroides*—2.5′ HT, flowers not showy, compound lobed leaves, blue berries in autumn, requires moist soil. 21, 66, 83, 120

Ceratostigma *plumabaginoides (Plumbago larpentiae)*–1′ HT, pure blue flowers in late summer, leaves dark green changing to red in the fall, spread readily. 9, 21, 27, 29, 37, 49, 52, 65, 67, 77, 83, 91, 95, 97, 98, 107, 109, 122, 133, 137, 144, 153, 157, 159, 165, 171, 175, 177, 183

Chamaelirium *luteum*—1.5′ HT, arching white flowers with yellow stamens, leaves narrow rich green. 66, 133, 157, 173

Chelidonium *majus*—2′ HT, yellow poppy-like blooms in late spring, dark green divided leaves. 69, 83

Chelone *glabra*—6′ HT, white to pink flowers in late summer. 29, 37, 66, 120, 127, 139

Chelone lyonii—3′ HT, rosy-pink flowers in late summer, dark green leaves, requires moist soil. 9, 29, 37, 39, 49, 61, 66, 77, 115, 117, 139, 157, 159, 173

Chelone obliqua—3′ HT, pink flowers in late summer, dark green leaves. 29, 83, 143, 159

'Alba'—white flowers. 159

Chimaphila *maculata*—10″ HT, dainty nodding white flowers in spring, leaves variegated, requires moist soil. 37, 54

Chrysogonum *virginianum*—8″ HT, golden-yellow stars in spring, evergreen rosettes similar to ajuga. 21, 49, 61, 65, 77, 83, 109, 113, 122, 123, 137, 144, 145, 153, 157, 159, 165, 171, 173

'Allen Bush'—similar to species but flowers over a longer period. 9, 37

australe—extended blooming time, more vigorous than species, stoloniferous. 117, 157, 181

'Mark Viette'—blooms all season. 9

Cimicifuga *americana*—5′ HT, white bottle brushes in late summer, divided compound leaves. 66, 133, 139

Cimicifuga dahurica—6′ HT, white flowers in late summer. 21

Cimicifuga elata—5′ HT, white flowers, divided dark green leaves. 139

Cimicifuga japonica—3′ HT, white flowers in late summer, divided dark green leaves. 173

'Acerina'—white flowers in fall, maplelike dark green leaves. 9, 21, 29, 143, 159, 173

Cimicifuga racemosa—5′ HT, white wands of flowers in summer. 9, 21, 29, 37, 39, 49, 66, 91, 107, 122, 133, 137, 139, 143, 159, 171, 173

'Atropurpurea'—purple-leaved form. 9, 83, 143

'Brunette'—bronzy brown leaves. 9

cordifolia—creamy white flowers in late summer, broad dark green leaves. 159

Cimicifuga simplex—4′ HT, arching white wands of flowers in fall, smooth green divided leaves. 9

'White Pearl'—4′ HT, large flower selection. 9, 21, 29, 37, 49, 83, 91, 107, 139, 143, 159, 165, 171

Claytonia *caroliniana*—10″ HT, pale pink flowers in spring, leaves light green tapered, requires woodland conditions. 37, 139

Claytonia parvifolia—8″ HT, pink and white flowers in spring, green rosettes of leaves, stoloniferous. 139

Claytonia virginica—6″ HT, white flowers with pink veining in spring, thin green leaves. 21, 25, 37, 54, 66, 83, 107, 109, 139

Clintonia *borealis*—1′ HT, greenish yellow flowers, broad glossy green leaves, blue berries in fall, requires moist woodland conditions. 66, 83, 120, 139

Codonopsis clematidea—1.5′ HT, soft blue flowers with a maroon-orange center in summer, leaves gray-green, climbing habit. 52

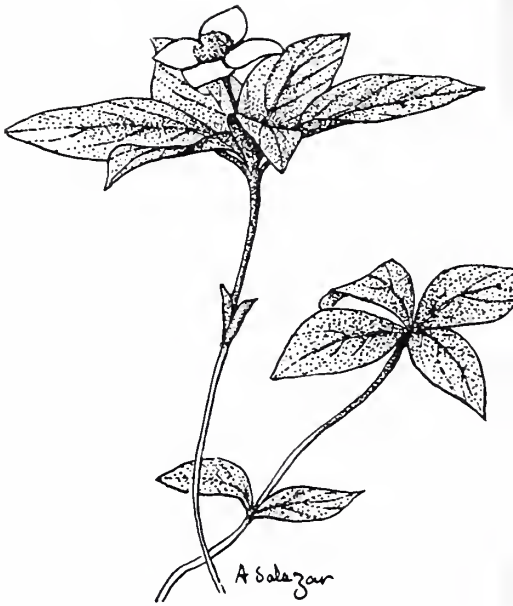
Codonopsis tangshen—3′ HT, olive-green and purple bells in summer, leaves purple tipped. 161

Commelina erecta—1′ HT, brilliant blue flowers in summer, sprawling stems, narrow leaves, requires some sun. 173

Conandron ramondioides nana—2″ HT, lavender flowers with an orange center in summer, leaves chartreuse toothed and crinkled. 145

Coptis groenlandica—6″ HT, white flowers with yellow stamens in late spring, leaves rounded and divided, requires moist soil. 120

Cornus canadensis—9″ HT, white dogwood flowers in late spring, whorled leaves, red fruit in fall, rhizomatous, requires cool moist soil. 29, 61, 120, 122, 133, 139, 145, 171



Cornus canadensis

Corydalis bulbosa—9″ HT, creamy gray to rich lilac flowers in spring, filigree blue green leaves dying down by midsummer. 133

Corydalis lutea—1′ HT, yellow spurred flowers blooming in all season, filgree green leaves. 9, 95, 98, 139, 159, 169

Cymbalaria muralis—3″ HT, pink flowers with a yellow throat, snapdragon-type flowers, leaves small lobed, trailing plant, good for walls, self seeds. 83, 175

'Globosa'—5″ HT, dwarf form. 98

'Globosa Alba'—dwarf form with white flowers. 144

Cypripedium acaule—1′ HT, pink pouch-type flowers with greenish purple petals in late spring, leaves soft hairy and green. 29, 37, 39, 41, 66, 83, 120, 143, 171

Cypripedium x *andrewsii*—8″ HT, petals greenish suffused with purple, pouch creamy white, blooms in late spring, leaves soft and hairy. 11

Cypripedium calceolus (pubescens)—1′ HT, clear yellow petals, rich red-brown pouch, leaves soft and hairy. 9, 66, 83, 171

Cypripedium reginae—1′ HT, white petals with a soft pink pouch. 120

Delphinium tricorne—1.5′ HT, bright blue to blue-violet flowers, leaves ephemeral. 11, 173

Dicentra canadensis—8″ HT, fragrant greenish white tinged purple flowers in spring, leaves gray-green finely cut. 37, 66, 139, 145, 173

Dicentra cucullaria—10″ HT, fragrant white hearts tipped with yellow in spring, gray-green leaves finely cut. 11, 21, 25, 29, 37, 45, 66, 133, 139, 145, 173

Dicentra eximia—1′ HT, cherry-pink hearts in spring to early summer and fall, leaves ferny gray-green. 3, 21, 25, 29, 37, 45, 66, 113, 117, 137, 139, 157, 159, 169, 177

'Alba'—white form. 9, 37, 49, 65, 91, 133, 153, 171, 175

'Bountiful' ('Zestful')—pink flowers, blue-green leaves. 9, 29, 37, 67, 91, 139, 143, 159, 169, 175

'Luxuriant'—deep rose-pink, more tolerant

of sun and heat. 9, 25, 29, 37, 45, 49, 54, 77, 83, 91, 97, 107, 122, 159, 169, 171

'Snowdrift'—white flowers blooming all season. 29, 139, 157, 159, 169

Dicentra formosa—1′ HT, pink flowers in spring through fall, leaves blue-green. 37, 95, 139

'Adrian Bloom'—rose-red flowers. 29

'Alba'—white flowers. 139

oregana—8″ HT, creamy white flowers tipped with pink in late spring through summer, leaves blue-green, requires good drainage. 145

Dicentra spectablis—3′ HT, rosy-red hearts, gray-green divided leaves dying back by midsummer, requires moist organic soil. 3, 9, 21, 33, 37, 45, 49, 63, 65, 67, 77, 83, 91, 97, 107, 137, 153, 157, 159, 169, 171, 175, 177, 183

'Alba' ('Pantaloons')—2.5′ HT, white form of species. 9, 21, 29, 37, 49, 63, 65, 71, 77, 83, 91, 97, 107, 133, 153, 159, 169, 177

Digitalis: will grow in sun or partial shade, bloom in early summer and are biennials or short-lived perennials.

Digitalis 'Apricot'—4′ HT, silvery apricot flowers, coarse green leaves. 175

Digitalis 'Dropmore Yellow'—3.5′ HT, flowers various shades of yellow. 173

Digitalis ferruginea—5′ HT, small coppery yellow veined brown flowers, leaves are slender green and smooth. 39, 83, 159

Digitalis 'Foxy'—2.5′ HT, cream lavender and deep purple flowers, smaller version of 'Excelsior Hybrids'—33, 37, 175

Digitalis grandiflora (ambigua)—2.5′ HT, soft creamy yellow flowers, reblooms in fall on shorter spike, leaves green, less coarse than other digitalis. 37, 39, 52, 65, 77, 83, 95, 97, 107, 117, 143, 153, 159, 169, 171, 173, 177, 183

'Temple Bells'—1.5′ HT, dwarf form of above. 37, 175

Digitalis lanata—2.5′ HT, small creamy yellow flowers with purplish tinting, leaves deep green, narrow. 37, 159

Digitalis laevigata—3′ HT, similar to *D. grandiflora* but with smoother leaves and yellow flowers with brown spotting. 173

Digitalis lutea—2′ HT, small creamy yellow flowers. 9, 37, 77, 83, 95, 159

Digitalis x *mertonensis*—2′ HT, rosy-mauve flowers flushed with copper, leaves coarse. 9, 27, 37, 39, 49, 65, 67, 77, 83, 95, 107, 143, 153, 159, 169, 171, 177, 183

Digitalis obscura—2′ HT, yellow veined, bright red flowers, leaves narrow and smooth. 52, 159

Digitalis parviflora—3′ HT, brownish purple flowers. 9, 49, 159

Digitalis purpurea—4.5′ HT, mix of pink, white, purple and apricot nodding flowers, spotted inside. 21, 37, 52, 75, 123

'Alba'—white form. 9, 37, 49, 159, 177

'Excelsior Hybrids'—flowers completely encircle the stem and are completely upright. 39, 52, 83, 107, 153, 159, 177

'Giant Shirley'—3.5′ HT, large flowered mix. 122, 169, 171

'Sutton's Apricot'—3.5′ HT, flowers shades of yellow and apricot. 173

Diphylleia *cymosa (muscipula)*—2′ HT, small white flowers, leaves large two lobed, rounded, indigo-blue berries, requires moist to wet soils. 66

Disporum *flavum*—2.5′ HT, nodding lemon-yellow bells in spring, bright green shiny leaves, tolerates dry shade. 145, 181

Disporum hookeri oreganum—2.5′ HT, creamy white to greenish white bells in spring, leaves long petioled. 139

Disporum lanuginosum—1.5′ HT, nodding greenish yellow flowers in spring, rounded leaves, hairy beneath, bright orange berries. 66, 144, 173

Disporum sessile—1′ HT, narrow cream flowers with green tips in spring, oblong pointed leaves, rhizomatous. 173

'Variegatum'—leaves streaked with white. 9, 37, 54, 121

Disporum smithii—2′ HT, nodding cream bells in spring, leaves rounded shiny and green, brilliant orange berries, requires some sun. 139, 145

Dodecatheon: All dodecatheons have reflexed petals with a pointed center resembling cyclamen. They require moist soil with good drainage and go dormant after flowering.

Dodecatheon alpinum—5″ HT, reddish purple flowers in spring, leaves linear smooth. 5, 145

Dodecatheon clevelandii patulum—5″ HT, creamy white flowers with a brown center in spring, leaves oblong toothed. 145

Dodecatheon dentatum—6″ HT, white flowers in spring, leaves crinkled green. 145

Dodecatheon hendersonii—10″ HT, reddish purple flowers in spring, leaves round fleshy. 139, 145

Dodecatheon jeffreyi—1.5′ HT, lavender flowers in spring, leaves long to oblong. 145

Dodecatheon meadia—1.5′ HT, pink-mauve flowers with a purple center and a ring of yellow, leaves smooth. 3, 9, 25, 29, 37, 66, 77, 117, 127, 133, 145, 153, 157, 159, 165, 173

'Album'—white flowers. 3, 139, 145

'Rosea'—soft rose flowers. 133

Dodecatheon pulchellum 'Redwings'—1′ HT, bright rose-carmine flowers with a yellow ring in spring, leaves oblong. 145

Eomecon chionantha—1′ HT, nodding white poppylike flowers in spring with yellow stamens, rounded leaves soft and green, rhizomatous. 173

Epimedium x *cantabrigiense*—small pink to orange flowers in the spring, leaves lustrous evergreen. 34, 159

Epimedium diphyllum—8″ HT, white nodding flowers in spring, spurless, heart-shaped leaves. 173

Epimedium grandiflorum (macranthum)—10″ HT, crimson flowers with long white-tipped spurs in spring, leaves deciduous, glossy. 9, 29, 54, 83, 107, 143, 159, 173

'Album'—white flowers. 9

'Queen Esta'—orchid-rose flowers with long white spurs. 34

'Rose Queen'—bright rose flowers, spurs tipped with white. 9, 159

'Violaceum'—lilac flowers with white spurs. 173

'White Queen' ('Snow Queen')—white flowers. 159

'Yenomoto'—white flowers. 34, 159

Epimedium perralderanum 'Frohnleiten'—1′ HT, yellow flowers in spring, leaves glossy, toothed, semievergreen. 9, 29, 83, 143, 159

Epimedium pinnatum—8-12″ HT, bright yellow flowers with purple spurs, leaves small and cleft. 9, 39, 45

colchicum ('Elegans' and 'Late Gold')—1′ HT, bright yellow flowers, very similar to species. 34, 137, 145

Epimedium x *rubrum* (*alpinum* 'Rubrum')—8-12″ HT, bright crimson flowers flushed with yellow and white in spring, new leaves red in spring, rhizomatous. 9, 21, 29, 37, 39, 52, 83, 91, 107, 137, 143, 145, 159, 171

Epimedium x *versicolor*—10″ HT, yellow and rose flowers in spring, leaves tinted with pink in spring and fall, rhizomatous. 54, 91, 159

'Sulphureum'—flowers yellow, leaves have a distinct pink tinge in spring and fall. 9, 21, 29, 37, 52, 77, 83, 107, 133, 137, 139, 143, 145, 159, 173

Epimedium x *warleyense*—10″ HT, orange flowers, light green leaves. 9, 34, 83, 143, 159

Epimedium x *youngianum*—1′ HT, white or rose flowers in spring

'Lilacinum'—10″ HT, lilac flowers. 83

'Niveum'—9-10″ HT, flowers white. 9, 21, 29, 37, 54, 77, 107, 133, 137, 139, 143, 159

'Roseum'—clear purplish-mauve flowers. 9, 21, 29, 37, 83, 91, 133, 137, 143, 159, 173

Epipactis *gigantea*—2′ HT, greenish-brown flowers in summer, leaves narrow green, rhizomatous. 145

Erinus *alpinus*—3″ HT, purple to pink flowers, leaves tufted coarsely toothed, requires excellent drainage. 49, 83, 121, 145

'Albus'—3″ HT, white flowers. 137, 145

Erinus oliverus—3″ HT, clearer pink flowers than *E. alpinus*. 145

Erythrina *herbacea*—3′ HT, deep red flowers in spring, leaves divided, black seed pods with scarlet seeds, requires excellent drainage, tender. 41

Euphorbia *robbiae*—2′ HT, green flowers in spring, rosettes of dark green leaves, rhizomatous, tolerates dry shade well. 34

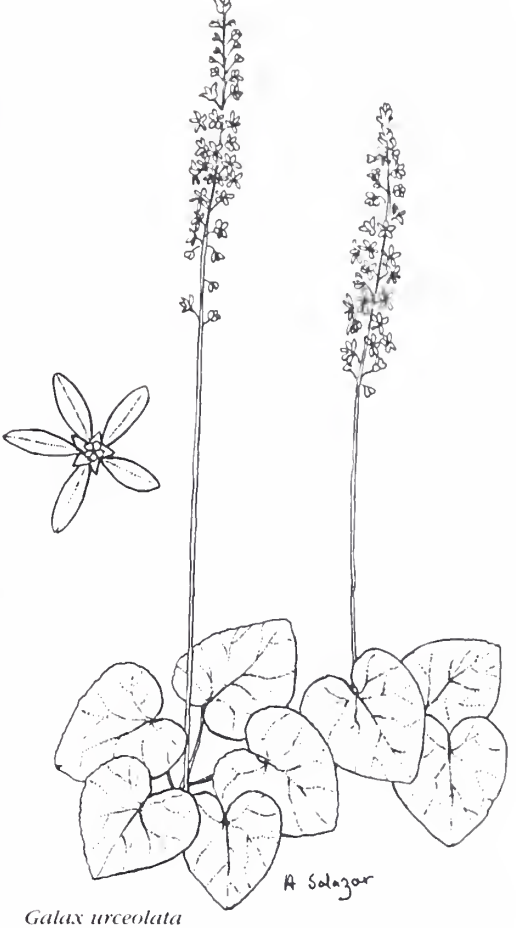
Euphorbia wallichii (longifolia)—1.5′ HT, yellow flowers in early summer, leaves have purplish edges with a white central vein, excellent foliage plant. 159, 171

Euphorbia wulfenii—4′ HT, cylindrical heads of gray-green flowers with yellow center, short narrow spiral leaves. 34

Fuchsia x *exoniensis*—2.5′ HT, bright red flowers from summer to fall with a purple bell inside, leaves dark green, sometimes purple tinged, requires rich soil. 37, 49, 95

Fuchsia magellanica—2.5′ HT, crimson flowers with a purple bell from summer to fall, requires rich soil. 61

'Maiden's Blush'—blush-white flowers, glossy pale green leaves. 95



Galax urceolata

'Pumila'—10″ HT, bright ruby-red flowers, dark green leaves. 95

'Senorita'—ruby-red flowers with a dark purple bell, leaves deep green with red veining. 95

'Tom Thumb'—10″ HT, miniature compact form, deep red flowers with a purple bell. 37, 95

'Variegata'—crimson flowers with a purple bell, leaves dark green shaded with red. 95

Fuchsia procumbens—prostrate habit, dark red flowers with a bright red bell, good for hanging baskets, tender. 95

Galax *urceolata (aphylla)*—1.5′ HT, white slender spikes in summer, dark shiny evergreen leaves turning crimson and bronze in fall, requires woodland conditions. 9, 21, 37, 54, 139

***Gaultheria** procumbens*—4″ HT, small white bells in spring, evergreen small roundish leaves, red berries in fall. 9, 37, 61, 65, 69, 77, 83, 120, 139, 143

***Gentiana** andrewsii*—1.5′ HT, tubular dark blue flowers in late summer, leaves pale green, requires moist to wet soils. 21, 37, 66, 83, 120, 127, 139, 157

Gentiana asclepiadea—2.5′ HT, rich pure blue flowers in fall, leaves light green lacelike on arching stems, requires moist soils. 37, 52, 171

'Alba'—2′ HT, white flowers. 145

Gentiana clausa—1′ HT, clear blue flowers in late summer, paler than *G. andrewsii*. 173

Gentiana dahurica—1′ HT, deep blue trumpet-shaped flowers spotted white in late summer, lance-shaped leaves. 3, 61, 65, 83, 143

Gentiana decumbens—10″ HT, deep blue bell-shaped flowers in late summer, lance-shaped leaves in rosettes on trailing stems. 3, 161

Gentiana dendrologi—14″ HT, white flowers in late summer, long lanceolate leaves. 143

Gentiana frigida 'Tatras'—6″ HT, yellow bell-shaped flowers spotted and streaked with blue, leaves tufted small and lance shaped. 11

Gentiana gracilipes—6″ HT, violet-blue flowers with a greenish tubular outside in late summer, rosettes of lance-shaped leaves. 61

Gentiana macrophylla—1.5′ HT, pale blue trumpet-shaped flowers in late summer, long lance-shaped leaves. 143

Gentiana makinoi—2.5′ HT, bright blue tubular flowers in late summer, lance-shaped leaves. 37

'Royal Blue'—2.5′ HT, deeper blue flowers. 83, 159

Gentiana scabra—10″ HT, large brilliant blue flowers in fall, dark green oval leaves on trailing stems. 11, 159, 173

Gentiana sino-ornata—4″ HT, deep azure-blue trumpet flowers in late summer, mats of narrow grassy leaves, stoloniferous. 3, 83, 145

Gentiana tianshanica—10″ HT, deep blue flowers in late summer. 161

Gentiana verna (angulosa)—4″ HT, azure-blue flowers in late spring, rosettes of small lance-shaped leaves, requires excellent drainage. 133

Gentiana villosa—1′ HT, yellow-green tinged blue tubular flowers. 173

Geranium: prefers moist humus-rich well drained soil, reblooms in fall and has reddish fall color.

Geranium macrorrhizum—1′ HT, pink flowers in early summer, leaves divided aromatic, semievergreen, good rich fall color. 37, 49, 95, 97, 139, 159

'Album'—white flowers. 49

'Bevans'—deep crimson-purple flowers. 171

'Ingwersen's Variety'—soft rose-pink flowers. 29, 33, 37, 77, 83, 107, 137, 144, 153, 159

'Minor'—deep pink flowers. 133

'Spessart' ('Spissant')—white petals with pink stamens. 9, 29, 37, 83, 91

Geranium maculatum—2′ HT, blush to rosy lilac flowers in spring, leaves large and deeply cleft. 11, 21, 25, 29, 37, 45, 49, 66, 83, 107, 113, 117, 120, 121, 127, 137, 139, 143, 144, 157, 173, 181

'Album'—2′ HT, white flowers. 37, 139

'Hazel Gallagher'—2′ HT, pure white flowers. 159

Geranium phaeum—2′ HT, nodding dark maroon flowers, soft green divided leaves. 83, 145

'Lily Lovell'—2.5′ HT, deep mauve flowers. 34

Geranium sylvaticum—2.5′ HT, violet-blue to

red-violet flowers in spring, leaves deeply cut. 159, 161

'Album'—white flowers. 181

'Mayflower'—rich violet-blue flowers. 83

Goodyera *oblongifolia*—1.5′ HT, small white flowers tinged with green, dark green leaves with white veins forming rosettes. 145

Goodyera pubescens—1.5′ HT, small creamy white flowers in summer, leaves gray-green with white veining forming rosettes. 66, 137, 139, 173

Habenaria *ciliaris*—2′ HT, orange or yellow fringed flowers in summer, lanceolate pointed leaves. 133

Haberlea *ferdinandi-coburgii*—4″ HT, hanging flower clusters of lavender outside, white spotted gold inside in late spring, hairy toothed leaves, requires moisture retentive soils. 133

Haberlea rhodopensis—4″ HT, bluish white flowers inside, lilac outside in spring, leaves dark green, leathery and smooth. 66

Helleborus niger

Helleborus, prefers moisture retentive soil and flowers in late winter to early spring.

Helleborus abschasicus—1.5′ HT, carmine-red flowers, bold dark green palmate leaves, evergreen. 145

Helleborus atrorubens—1.5′ HT, violet-purple flowers, dark green deeply lobed leaves, deciduous. 9, 171

Helleborus foetidus—1.5′ HT, pale green bell-shaped flowers with rose margins, black-green deeply divided leaves. 9, 37, 95, 109, 145, 153, 159, 181

Helleborus lividus corsicus—2′ HT, pale green bell flowers, grayish green prickly evergreen leaves. 95, 109, 145, 171

Helleborus niger—1.5′ HT, white flowers with gold stamens, dull green leathery evergreen leaves. 9, 37, 91, 133, 153, 159, 177

'White Magic'—large pure white flowers with clusters of yellow stamens. 171

Helleborus olympicus—1.5′ HT, large white bell flowers, leathery divided toothed leaves. 11

Helleborus orientalis—1.5′ HT, blush white to plum flowers spotted with maroon and crimson, dark green deeply lobed leaves, evergreen. 9, 11, 27, 37, 49, 77, 91, 109, 122, 133, 137, 139, 153, 157, 159, 171, 181

'Millet Hybrids'—1.5′ HT, mixed flowers of white, pink, red, larger than species. 95

Hepatica *acutiloba*—8″ HT, white or pale pink flowers in early spring, mottled, lobed, sharp tipped leaves, semievergreen, requires moist to wet soils. 25, 29, 37, 45, 66, 139, 145, 173

Hepatica americana (triloba)—5″ HT, violet-blue flowers in early spring, rounded, mottled leaves, semievergreen, requires moist soils. 21, 37, 45, 66, 83, 107, 120, 133, 137, 139, 143, 144, 145, 157, 173

Hepatica nobilis—6″ HT, heart-shaped leaves, purple and silky beneath, blooms in early spring, requires moist soils. 83

Hosta: prefers partial shade and moist soil, most will tolerate full sun with adequate moisture except those with yellow and heavily variegated leaves.

Hosta collection—9, 27, 29, 37, 41, 45, 49, 54, 75, 77, 95, 133, 139, 143, 159, 165, 167, 169, 177

Hosta clausa—1′ HT, purple flower spikes in late summer, oblong green leaves. 29

normalis—1.5′ HT, purplish blue flower spikes, narrow, green leaves. 29

Hosta crispula—2.5′ HT, lilac trumpet-shaped flowers in early summer, white wavy margined leaves. 29, 83

Hosta decorata—2′ HT, lilac flower spikes in early summer, oval white edged leaves. 139, 159

Hosta elata—2.5′ HT, pale lilac flower spikes, pale green leaves with wavy edges. 29

Hosta fortunei—2.5′ HT, lilac flowers in summer, sage-green pointed leaves with a wavy edge, creamy yellow fall color. 91

'Albo-picta'—bright butter-yellow leaves edged with pale green later changing to tones of soft green. 29, 153, 159, 169, 177

'Antioch'—29, 67, 77, 169

'Aureomaculata'—dark green leaves with yellow-green centers. 3, 21, 83, 137, 139

'Aureomarginata'—dark green leaves with a yellow margin. 21, 27, 29, 33, 77, 83, 107, 169

'Hyacinthina'—bold gray-green leaves edged with a thin line of glaucous gray. 21, 29, 65, 83, 137, 153, 157, 169, 177

'Marginato-alba'—sage-green leaves with white wavy edges. 21, 27, 63, 65

'Moerheimii'—green leaves with a creamy edge. 29

'Obscura'—shiny oval dark green leaves. 29, 65, 153

Hosta helonoides 'Albo-Picta'—1′ HT, lilac flowers in late summer, narrow leaves with a thick yellow edge. 29

Hosta 'Honeybells'—3′ HT, fragrant lilac flower spikes in late summer, leaves light green with wavy edges. 21, 29, 52, 63, 65, 77, 83, 91, 107, 133, 137, 139, 153, 159, 169, 177

Hosta lancifolia—2′ HT, lilac flower spikes in late summer, shiny dark green pointed lance-shaped leaves. 21, 52, 63, 65,67, 77, 83, 91, 97, 107, 153, 159, 169, 177, 183

'Albomarginata'—leaves green with white edges. 83

'Hauser's Narrow Leaf'—narrow dark green shiny leaves. 137

Hosta longissima—1.5′ HT, lilac flower spikes in late summer, small narrow dark green leaves. 137, 173

Hosta montana—3′ HT, blue flower spikes in fall, rich green, narrowly heart-shaped, deeply veined leaves. 29

'Aurea-marginata'—rich green leaves with broad yellow margins. 27, 29, 169, 171, 177

Hosta plantaginea—2′ HT, white fragrant flowers in fall, large heart-shaped yellow-green leaves. 133, 137, 159, 169

'Grandiflora'—white fragrant flower spikes, longer and narrower than above. 29, 83, 171, 177

Hosta 'Royal Standard'—3′ HT, bluish white fragrant flowers, broad, heart-shaped, rich green leaves with wavy edges. 21, 27, 29, 52, 63, 65, 67, 77, 83, 107, 122, 137, 153, 159, 169, 171, 177

Hosta sieboldiana—2.5′ HT, white to lilac flowers in summer, broad deep gray-green pointed leaves, creamy yellow fall color.

'Blue Giant'—large blue-gray leaves, crinkled and deeply veined. 137

'Dr. Hale'—3′ HT, white flowers, large quilted gray-green leaves. 137

'Elata'—pale mauve flowers, large wavy blue-gray leaves. 137

'Elegans'—large blue-gray leaves, crinkled and deeply veined. 21, 29, 77, 83, 91, 107, 122, 139, 159, 169, 171, 177

'Frances Williams' ('Gold Edge')—similar to 'Elegans', but with a yellow margin. 29, 77, 83, 107, 137, 159, 169, 171

'Golden Sunburst'—golden-yellow leaves. 29, 159

'Mira'—white flowers, large deeply quilted leaves. 29, 137

Hosta sieboldii (albomarginata)—2.5′ HT, violet flower spikes in summer, green leaves with a narrow white to yellow margin. 29, 52, 75, 91, 139, 159

'Alba'—white flowers. 29, 159

Hosta tardiflora—1′ HT, mauve flower spikes in fall, narrow shiny dark green leaves. 29, 137, 181

Hosta tokudama—1.5′ HT, white to lilac flowers in summer, heavily corrugated glaucous leaves. 29, 137, 181

'Aureo-nebulosa'—white flowers, glaucous leaves striped with a yellowish green. 159, 169

'Flavo-circinalis'—off-white flowers, glaucous leaves with chartreuse edges. 159

Hosta undulata—3′ HT, pale lavender flowers in spring, broad ovate leaves striped with creamy yellow.

'Albo-marginata'—1.5′ HT, lilac flowers in summer, leaves spirally twisted and pointed with a white margin. 3, 29, 33, 67, 77, 137, 159, 169, 177, 183

'Erromena'—4′ HT, lilac flowers, broad rich green leaves. 27, 29, 65, 83, 153, 159, 177

'Mediopicta' ('Variegata')—twisted leaves with a creamy white center and dark green margin. 21, 29, 33, 65, 67, 91, 107, 153, 169, 171, 183

'Univittata'—2′ HT, similar to 'Mediopicta', but more vigorous and taller. 29, 137, 177

Hosta ventricosa (caerulea)—4′ HT, violet flower spikes in late summer, broad dark green heart-shaped leaves with wavy edges. 25, 29, 33, 65, 91, 137, 153, 169, 171, 177

'Aureo-marginata' ('Variegata')—leaves edged with cream. 29, 91, 159, 169

Hosta venusta—1′ HT, pale purple flowers in summer, small oval leaves. 29, 77, 121, 137, 159, 173

Hutchinsia alpina—4″ HT, white flowers in late spring, tufted lacy dark green leaves, requires moist soil. 83, 133

Hydrophyllum appendiculatum—2′ HT, pale violet flowers in late spring, deeply lobed leaves, requires moist rich soil. 143

Hylomecum japonicum (Chelidonium japonicum)—1′ HT, butter-yellow poppylike flowers in spring, fresh green divided leaves. 145

Isopyrum biternatum—10″ HT, small white anemonelike flowers in spring, fernlike divided leaves, requires moist soil. 25, 173

Jeffersonia diphylla—10″ HT, white flowers in spring, leaves in pairs, kidney-shaped, decorative leathery seed capsules, requires moist organic soil. 11, 113, 137, 139, 145, 157

Jeffersonia dubia—10″ HT, soft blue flowers in spring, irregularly margined heart-shaped leaves, requires moist organic soil. 11

Kirengeshoma palmata—3′ HT, yellow shuttlecock flowers in fall, lobed leaves with pointed tips and dark stems, requires moist to wet soils. 9, 29, 34, 37, 91, 107, 143, 159

Lamiastrum galeobdolon—2′ HT, small yellow flowers in spring, heart-shaped leaves, stoloniferous, tolerates dry shade, but prefers moist soil. 91

'Herman's Pride'—1′ HT, silver leaves with green veins. 9, 21, 27, 29, 37, 49, 52, 61, 65, 67, 77, 91, 109, 143, 144, 153, 159, 161, 169, 171

'Variegatum'—1.5′ HT, leaves marked with silver. 21, 37, 61, 65, 83, 98, 143, 153, 159, 165, 169

'Variegatum Compactum'—6″ HT, dwarf form. 37, 49, 61, 159

Lamium maculatum—1′ HT, purple-red flowers in spring, heart-shaped leaves spotted white, stoloniferous, tolerates dry shade, but prefers moist soils. 51, 95, 183

'Album'—10″ HT, white flowers, dark green leaves marbled with white. 9, 37, 49, 52, 61, 65, 133, 153, 177

'Aureum'—10″ HT, leaves tinted yellow. 49, 133, 143, 169

'Beacon Silver'—10″ HT, pink flowers, silver leaves with green edging. 9, 27, 34, 37, 45, 49, 61, 63, 65, 83, 95, 97, 98, 107, 122, 133, 143, 153, 157, 159, 169, 171, 183

'Chequers'—10″ HT, deep pink flowers, deep green leaves with white stripes in center. 37, 49, 65, 67, 143, 153

'Shell Pink'—10″ HT, pink flowers. 9

'White Nancy'—10″ HT, white flowers, silver leaves edged with green. 9, 29, 34, 37, 49, 61, 65, 67, 77, 91, 95, 107, 109, 133, 143, 153, 159, 183

Lewisia columbiana—1′ HT, evergreen straplike leaves in rosettes, pink and white flowers with red veins in spring and summer, requires excellent drainage.

'Edithae'—salmon flowers with pink stripes on petals. 145

'Wallowensis'—5″ HT, dwarf form. 121

Lewisia cotyledon—1′ HT, pink candy-striped flowers, evergreen basal fleshy leaves, requires excellent drainage. 83, 133, 139, 145, 161

'Sunset Hybrids'—mixed flowers of pink and red. 3

Lewisia leana—8″ HT, small magenta flowers, evergreen leaves in clusters, requires excellent drainage. 145

Lewisia 'Trevosa'—10″ HT, star-shaped salmon-red flowers in early summer, narrow rosettes of leaves, requires excellent drainage. 145

Lewisia tweedyi 'Alba'—8″ HT, large white flowers in late spring, evergreen basal fleshy broad leaves, requires excellent drainage. 145

Ligularia: all require moist boggy soil and flower in summer unless noted.

Ligularia dentata (clivorum)—4′ HT, orange daisies, leathery heart-shaped leaves. 37, 65, 91, 95, 153, 165

'Desdemona'—leaves rich dark purple above, mahogany red below. 9, 21, 29, 37, 77, 83, 91, 133, 153, 159, 165, 169, 171, 177

'Dunkellaubig'—4′ HT, bright orange daisies. 37, 65, 153, 165

'Greynog Gold'—6′ HT, orange flowers. 91, 153

'Orange Queen'—3′ HT, orange flowers. 83

'Othello'—similar to 'Desdemona,' but less purple-flushed. 9, 29, 37, 83, 91, 107, 143, 159, 165

Ligularia x *bessei*—3′ HT, orange-yellow flowers on a conical spike, green leathery heart-shaped leaves. 9, 21

Ligularia hodgsonii—3′ HT, yellow and orange flowers, leaves kidney-shaped, sharply toothed. 153, 159, 165

Ligularia japonica—5′ HT, orange flowers in early summer, deeply cut and segmented leaves. 83

Ligularia przewalskii—6′ HT, spikes of small clear yellow flowers, dark green deeply lobed leaves. 9, 21, 29, 52, 61, 143, 159, 165, 169

'The Rocket'—5′ HT, spikes of bright yellow flowers on dark stems, dark green rounded leaves. 9, 21, 29, 37, 39, 65, 77, 83, 91, 107, 143, 153, 159, 165, 169, 177

Ligularia 'Sungold'—3′ HT, golden-yellow flowers. 37, 153

Ligularia tussilaginea—2′ HT, orange-yellow flowers.

'Argentea'—green leaves with silver and cream marbling. 54

'Aureo-maculata'—leaves spotted with white, yellow or pale pink. 49

Linnaea borealis—2″ HT, small pink bell flowers in spring, evergreen, small round leaves, requires moist organic soil. 61, 139, 145

americana—longer flowers. 120

Liriope muscari—1′ HT, violet flower spikes in late summer, grasslike tufts of evergreen leaves, requires well drained moist organic soil, will tolerate dry shade, but prefers sun. 21, 27, 37, 67, 91, 165

'Christmas Tree'—larger flowers spikes. 9, 37, 41

'Densiflora'—leaves tall and slender. 37

'Gold Banded'—deep green leaves with narrow gold margins. 9, 37, 41, 49, 171

'John Burch'—leaves with a chartreuse central band. 9, 37

'Lilac Beauty'—deep lilac flowers, leaves green. 9, 37, 41, 49

'Majestic'—15″ HT, deep lilac flowers, more vigorous. 49, 65, 91, 153, 159, 171

'Monroe White'—large white flower spikes. 9, 21, 37, 49, 165, 173

'Monroe'—white flower spikes. 41

'Regal'—violet flowers, narrow green leaves. 165

'Royal Purple'—rich purple spikes. 9, 37

'Silver Midget'—10″ HT, lilac-purple flowers, irregular variegation on dark green leaves. 9, 37, 173

'Silvery Sunproof'—leaves variegated with creamy white stripes, tolerant of more sun. 9, 37, 41, 173

'Tidewell's Big Blue'—larger flower spikes, dark green leaves. 165, 173

'Variegata'—green and yellow leaves. 9, 27, 37, 49, 67, 91, 159, 165

'Webster Wideleaf'—broad arching leaves. 37, 91

Liriope spicata—8″ HT, pale violet flowers, grasslike dark green leaves, rhizomatous, invasive, tolerates dry shade. 21, 37, 49, 52, 65, 91, 143, 153, 159, 165, 173

'Franklin Mint'—1′ HT, violet flowers. 37

'Majestic'—10″ HT, pale violet flowers. 29, 169

Lobelia cardinalis—3′ HT, scarlet flowers in late summer, shiny basal leaves, requires moist to wet soils, short-lived perennial. 9, 21, 25, 27, 29, 33, 37, 39, 45, 49, 52, 61, 65, 66, 77, 83, 107, 109, 113, 115, 117, 123, 127, 133, 137, 139, 143, 153, 157, 159, 171, 173, 177, 181

'Alba'—white flowers. 39

Lobelia siphilitica—2.5′ HT, soft blue to dark blue flowers in late summer, light green coarse leaves, requires moist to wet soils. 9, 21, 25, 37, 52, 66, 69, 113, 115, 117, 121, 123, 133, 139, 143, 157, 171, 173, 177

'Alba'—white flowers. 173

Lunaria annua—2.5′ HT, white or purple flowers in spring, rounded dark green coarsely toothed leaves, biennial. 63, 107, 169, 183

'Munstead'—velvety purple flowers, decorative round flat silvery seed pods. 33, 52

Lysimachia nummularia 'Aurea'—1″ HT, yellow-green leaves. 41, 65, 67, 83, 117, 133, 143, 144, 153, 171

Maianthemum bifolium—10″ HT, small starry white flowers in spring, long heart-shaped leaves, requires moist to wet soils. 139

Maianthemum canadense—3-6″HT, white flowers in spring similar to *M. biflorum*. 25, 66, 120

Medeola virginica—2′ HT, green and brown hanging flowers in spring, shiny whorled leaves, requires moist soils. 66

***Meehania** cordata*—3″ HT, bright lavender mint flowers in late spring, oval hairy leaves, requires moist organic soil. 173

***Mertensia** platyphylla subcordata*—2.5′ HT, blue flowers in spring, oval pointed hairy leaves, dormant in summer. 139

Mertensia virginica—2′ HT, violet-blue flowers in spring, smooth gray leaves, dormant in summer. 9, 11, 21, 25, 27, 29, 37, 66, 83, 107, 113, 133, 137, 139, 143, 157, 159, 171, 173, 177

***Mitchella** repens*—2″ HT, pinkish-white fragrant trumpet flowers in late spring, evergreen dark leaves with pale veins, red berries in fall, requires moist acid organic soil. 9, 21, 37, 61, 66, 77, 83, 109, 123, 133, 143, 157, 173

Mitella diphylla—15″ HT, white flower spikes in spring, heart-shaped basal leaves, requires moist organic soils. 66, 120, 157, 173

Mitella nuda—8″ HT, yellowish green flower spikes, heart-shaped basal leaves. 120

***Monarda** clinopodia*—3′ HT, white spotted purple flowers in early summer, lance-shaped leaves, requires moist organic soils. 115, 157, 173

***Moneses** uniflora*—3″ HT, white nodding fragrant flowers in summer, evergreen shiny mats of leaves, requires cool acid organic soil. 120

***Omphalodes** cappadocica*—10″ HT, blue flowers with a white center in spring, oval pointed gray-green leaves, requires moist soil and tolerates dense shade. 9, 145

Omphalodes verna—8″ HT, blue flowers with white centers in spring, green oval lance-shaped leaves, rhizomatous, requires moist soil. 9, 61, 83, 159, 171

***Ophiopogon** intermedius*—1′ HT, small white flower spikes, grasslike tufted leaves. 144

Ophiopogon japonicus—10″ HT, small lilac flowers pikes in late summer, dark green grasslike leaves, blue berries, stoloniferous, requires moist soils. 21, 37, 49, 83, 91, 144, 171, 173

'Compactus'—2″ HT. 133, 145

'Gracilis Variegata'—5″ HT, leaves slender with white stripes. 54

'Gyoko-Ryu' ('Kiyoto')—3″ HT, tiny dark green leaves. 9, 91

'Minor'—8″ HT. 83

'Nanus'—4″ HT. 37, 41, 49, 54

'Nippon'—10″ HT, similar to species. 159

'Shiroshima Ryu'—4″ HT, leaves striped with white. 37

'Silver Dragon'—1′ HT, olive-green leaves with white stripes. 37, 41

Ophiopogon planiscapus—6″ HT, white or pale purple flower spikes in late summer, blue fruit. 65

'Nigrescens' ('Arabicus' and 'Ebony Night')—6″ HT, pink flowers, shiny blue fruit, dark purple-black leaves. 9, 37, 41, 83, 91, 171

***Orchis** spectabilis*—1′ HT, violet-purple and white flowers in late spring, dark glossy green oval basal leaves. 66

***Ourisia** macrophylla*—1′ HT, white snapdragon flowers in early summer, oblong leathery leaves, requires rich acid soil. 145

***Pachysandra** procumbens*—6″ HT, white flowers in spring before leaves emerge, semi-evergreen dark green leaves with silvery blotches and a bronze cast, groundcover. 9, 37, 54, 77, 91

Pachysandra terminalis—10″ HT, small white flower clusters in spring, evergreen groundcover. 3, 27, 37, 66, 67, 83, 91, 169, 183

'Cut Leaf'—10″ HT, deeper green leaves with serrated edges. 37

'Green Carpet'—10″ HT, rich deep green shiny leaves, more compact habit. 27, 37, 67, 95, 122, 133, 171

'Silver Edge' ('Variegata')—3, 37, 65, 67, 83, 91, 95, 133, 143, 153, 171

***Pedicularis** canadensis*—18″ HT, yellow or red flowers in spring, coarse divided leaves, somewhat parasitic. 66, 123

***Peltoboykinia** tellimoides*—2′ HT, white flowers with yellow centers in early summer, slightly lobed rounded leaves, prefers moist soils. 9, 173

***Phacelia** bipinnatifida*—2′ HT, lavender-blue bell-shaped flowers in spring, silvery green hairy dissected leaves, requires moist soils. 113, 157

***Phlox** adsurgens*—1′ HT, salmon to pink petals with dark central stripe in late spring, evergreen, requires acid soils, tender. 145

Phlox divaricata—1′ HT, lavender-blue flowers with notched petals in spring, small narrow leaves, requires moist organic soil. 11, 25, 41, 45, 49, 66, 109, 120, 133, 143, 173, 181

'Alba'—white flowers. 109, 113

'Chattahoochee'—lavender flowers with a red center. 9, 37, 49, 77, 109, 133, 137, 145

'Dirgo Icicle'—pale ice-blue flowers. 9, 37, 45, 145, 159

'Eco Notchless White'—white unnotched flowers. 54

'Eco Blue Cherub'—6″ HT, blue flowers, broader leaves. 54

'Fuller's White'—large white flowers. 9, 21, 27, 29, 37, 49, 65, 107, 133, 137, 143, 153, 157, 159, 165, 169, 173, 177, 181

'Laphamii '—large rich blue-violet flowers. 9, 29, 37, 49, 95, 143, 157, 159, 165, 177

'London Grove Blue'—larger pure blue flowers. 159

'Sherwood Purple'—157

'Spring Delight'—15″ HT, bright rose-pink flowers. 37

Phlox stolonifera—10″ HT, creeping violet flowers in spring, oval lance-shaped leaves, stoloniferous, requires moist organic soils. 52, 66, 91, 109, 173, 181

'Alba'—white flowers. 109, 133

'Arianne' ('Bruce's White')—white flowers with a small yellow eye. 9, 21, 37, 49, 77, 121, 159, 169, 173, 181

'Blue Ridge'—sky blue flowers. 9, 21, 37, 49, 77, 95, 98, 109, 121, 137, 145, 159, 169, 173, 177

'Blue Eye'—144

'Eco Redfield Blue'—true blue flowers. 54

'Home Fires' (wheeryi)—rosy-pink flowers. 54, 159, 169

'Iridescens'—pink flower with blue shadings. 9, 49, 54, 109, 121

'Osborne's White'—white flowers. 177

'Pink Ridge'—pastel pink flowers. 11, 21, 37, 49, 77, 115, 133, 137, 145, 159, 173, 177, 181

'Purple Queen'—purple flowers. 121

'Sherwood Purple'—deep blue flowers. 21, 37, 49, 54, 133, 159, 177

***Podophyllum** hexandrum (emodi)*—1.5′ HT, nodding cupped white to pink flowers in spring, large egg-shaped bright red edible fruit, brownish deeply lobed leaves in pairs. 83

Podophyllum peltatum—2′ HT, greenish white flowers in spring, large fruit, single lobed leaves. 21, 25, 37, 41, 45, 66, 107, 120, 137, 139, 143

***Polemonium** carneum*—2′ HT, pale cream pink flowers in late spring. 145

***Polygala** chamaebuxus*—1′ HT, pale yellow flowers in late spring, evergreen leathery oval lance-shaped leaves, rhizomatous. 11, 145

grandiflora—wine-red flowers with a yellow tip. 145

Polygala paucifolia—5″ HT, butterflylike rich rose-purple flowers with a fringed white tip in late spring, shiny oval pointed clustered leaves, rhizomatous, requires moist organic soil. 11

Polygonatum: are rhizomatous, prefer moist organic soils, produce hanging flowers, have buttery yellow fall color and blue-black berries.

Polygonatum biflorum—3′ HT, yellowish white flowers with green tips in spring, rounded lance-shaped leaves on arching stems. 21, 25, 29, 37, 45, 49, 61, 63, 66, 120, 123, 139, 144, 157

Polygonatum commutatum—5′ HT, small white bellflowers with green tips in late spring, large rounded leaves on arching stems. 11, 21, 37, 49, 66, 83, 113, 139, 143, 159, 173

Polygonatum falcatum (humile)—8″ HT, dwarf version of *P. biflorum*. 9, 54, 133, 145, 173

Polygonatum multiflorum—3′ HT, greenish white flowers with green tips in multiple groups in late spring, oval lance-shaped leaves on arching stems. 9, 49

Polygonatum odoratum—2′ HT, white flowers with greenish tips in late spring, oval lance-shaped leaves on arching stems. 41

thunbergii 'Variegatum'—leaf edge is streaked with white. 9, 27, 29, 37, 39, 41, 49, 54, 122, 143, 159, 169, 171, 173, 181

Primula: all require moist organic soil.

Primula allionii—3″ HT, large pink and white flower clusters, thick leathery leaves, requires protection from winter moisture and requires well-drained soils. 145

'Elliott'—darker pink flowers. 145

Primula alpicola violacea—16″ HT, purple, violet fragrant flowers in summer, oblong crinkled leaves. 161

Primula auricula—8″ HT, mixed fragrant flowers of yellow, red and purple, broad fleshy leaves, require good drainage. 37, 83, 95, 133, 161

'Creamy White Select'—white flowers. 139

'Dale's Red'—bright brick-red flowers with a yellow center. 145

'Dark Purple Select'—dark purple flowers. 139

'Rapp Purple'—large rich purple flowers. 145

'Yellow Strain'—yellow flowers. 11, 133, 139

Primula cortusoides—10″ HT, magenta cleft flowers in late spring, thin broad scalloped leaves. 11, 161

Primula daonensis—4″ HT, brilliant rose-pink notched flowers, short oblong lance-shaped leaves edged with rusty hairs. 145

Primula darialica—6″ HT, rosy flowers with a yellow eye, squat growth habit. 145

Primula denticulata (cashmeriana rubens)—15″ HT, shades of purple flowers with a yellow eye in spring, oblong waxy edged leaves, dormant in summer. 3, 9, 37, 61, 83, 95, 109, 133, 139, 159, 161, 177

'Alba'—white flowers. 9, 27, 52, 139, 159, 161, 177

'Dark Shades'—dark color mix. 161

'Ronsdorfer Hybrids'—mixed colors. 139, 161

'Nepal'—mauve flowers. 83

'Purpurea'—purple shades. 83

'Rubin'—red shades. 9

'Ruby'—carmine-red flowers. 161

Primula elatior—8″ HT, sulphur-yellow flowers in spring, oblong crinkled leaves. 75, 109, 161

Primula farinosa—10″ HT, lilac, purple and pink flowers with a yellow eye in early summer, silvery green leaves, downy beneath. 121

Primula florindae—4′ HT, fragrant citron-yellow umbels in summer, large rounded leaves. 159

'Kaillour Hybrids'—lavender, yellow and pale red flowers. 159

Primula frondosa —6″ HT, rosy-pink flowers, silvery farinose leaves, finely toothed, prefers gravelly soil. 109, 133

Primula intercedens - 1.5′ HT, lilac umbels in summer, wedge-shaped leaves, yellow downy beneath. 11

Primula japonica—2′ HT, whorled pink, red and purple flowers in late spring, oval oblong crinkled leaves. 9, 37, 109, 121, 133, 139, 159, 173

'Alba'—white flowers. 52, 161

'Carminea'—carmine flowers. 161

'Fuji'—white flowers. 137

'Miller's Crimson'—vivid crimson flowers. 159, 161, 177

'Moerheim's Hybrids'—83

'Mt. Etna'—bright red flowers. 137

'Potsford's White'—luminous white flowers with an apricot eye. 177

'Rubra'—red flowers. 121

Primula juliae—6″ HT, mixed flowers in spring, small heart-shaped leaves. 159

'Alba'—white flowers. 139

'Dorothy'—light yellow flowers. 121, 139

'Garryard Guinevere'—4″ HT, soft pink flowers, bronze leaves in spring. 145

'Groenekans Glory'—83, 133

'Jack-in-the-Green'—121

'Jay-jay'—4″ HT, glowing cerise flowers. 145

'Lois Lutz'—144

'Lize Green'—83

'Norman Deno'—bright rosy-red flowers. 54

'Purpurkissen'—purple-red flowers. 83, 139

'Royal Velvet'—4″ HT, deep red flowers. 133

'Wanda'—violet-purple flowers. 37, 83, 95, 121, 133, 139, 177

Primula kisoana—8″ HT, deep rose-pink flowers in late spring, hairy geranium-shaped leaves, dormant in summer, stoloniferous. 109

'Millstream Pink'—pink flowers. 54

Primula marginata—3″ HT, pale lavender to lilac flowers with a powdery pale center, sharply toothed farinose leaves with a white edge on branching stems, requires stony soil. 3, 145

Primula minima 'Tatras'—11

Primula 'Peter Klein'—4″ HT, rose-pink flowers. 145

Primula polyneura—10″ HT, bright rose-violet flowers with a yellow eye in late spring, oval lobed hairy leaves. 11, 161

Primula x *polyantha*—8″ HT, mixed fragrant flowers of yellow, red, purple and pink umbels, oval crinkled leaves. 9, 33, 67, 109, 133, 159, 177

'Cowichan'—solid-colored velvety maroon flowers, bronze-purple crinkled leaves. 139

'Dwarf Jewel'—mixed flowers of yellow, pink, blue and red. 27

'Eco Rose Giant'—large rose flowers with a gold eye. 54

'Eco White Pinwheel'—fringed white flowers with a gold eye. 54

'E. R. Janes'—10″ HT, purple pink flowers with a yellow eye. 133

'Gold Lace'—maroon flowers with a gold border. 54, 109

'Jewel'—mixed colors. 37, 133

'Moonlight'—pale yellow flowers. 133

'Old Fashioned Yellow'—soft sunshine-yellow flowers. 133

'Pacific Giant Mix'—large flowered mix. 37, 95, 107, 171

Primula x *pubescens*—8″ HT, yellow or mauve flowers with yellow or white centers, fleshy oblong leaves, requires stony soil. 3, 109

Primula rosea—10″ HT, glowing rose-pink

flowers in spring, oblong leaves, prefers dry soil in winter. 161

Primula sieboldii—1′ HT, magenta-rose notched flowers in late spring, crinkly oval hairy leaves, dormant in summer. 121, 145

'Akatonbo'—darker and lacier flowers. 145

'Benkeijo'—purple-red flowers with a white eye. 145

'Fimbriated Red'—bright cerise flowers deeply cut and notched. 145

'Fringed White'—white frilled flowers. 133

'Isotaka'—frilled white edged flowers backed with purple-pink. 145

'Musashino'—pale rose-pink flowers with darker reverse. 145

purpurea—smaller vivid purple-red flowers. 145

'Shi-un'—lavender-blue frilled flowers. 145

'Snowflake'—wide petalled white flowers. 145

'Sumina'—large lavender-blue flowers. 145

'Yubisugata'—frilled lavender flowers splashed white with pure white on the reverse and white in the center. 145

Primula spectabilis—5″ HT, rose-pink flowers in late spring, flat rosettes of leaves with pitted surface and oval lance-shaped leaves, requires stony soil. 133

Primula veris—10″ HT, orange-yellow fragrant flowers in late spring, oval oblong leaves. 9, 109, 161, 173

canescens (macrocalyx)—11

'Collossea'—larger flowers. 97

'Crescendo Blue'—blue flowers. 83

'Judy'—cream flowers. 9

'Rubra'—red flowers. 83

'White'—white flowers. 159

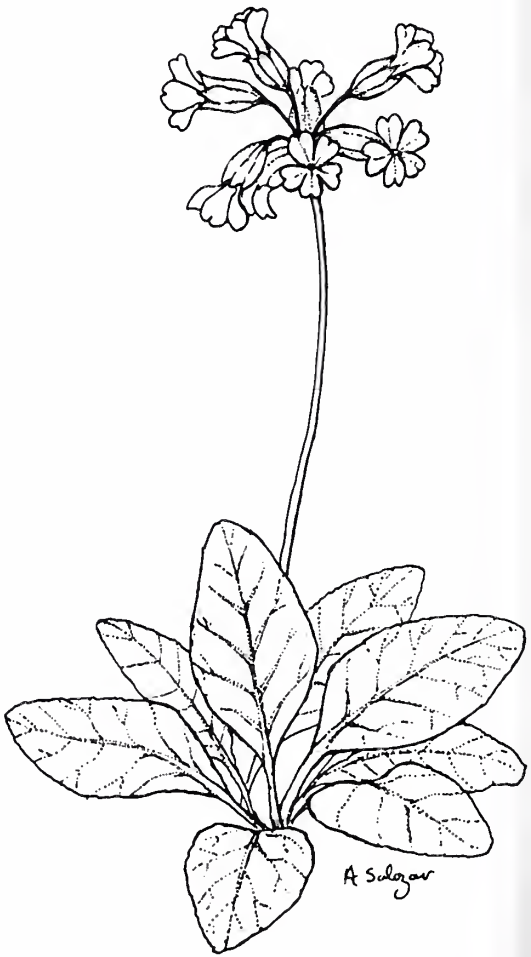
'Yellow'—yellow flowers. 83

Primula vialii—1.5′ HT, bluish-violet flowers in summer on narrow cylindrical cones, erect silvery narrow leaves. 3

Primula viscosa (latifolia)—5″ HT, umbels of clear pink flowers in late spring, sticky oblong lance-shaped leaves, requires stony soil. 145

Primula vulgaris (acaulis)—6″ HT, red, white, yellow and purple flowers in spring, oblong crinkled dark green leaves. 3, 9, 109, 133, 157, 161

'Finesse Hybrids'—159



Primula veris

'Mark Viette'—double deep pink flowers. 9, 37, 171

'Mexicana'—red and gold flowers. 137

'Pagent Series'—mixed colors. 161

sibthorpii (rubra)—large pink flowers with a yellow eye. 139

'Wanda'—magenta-purple flowers. 159

Primula warshnewskiana—3″ HT, bright rose umbels of flowers. 109

'Pamir'—11

Pulmonaria: prefer moist humus-rich soils except where noted.

Pulmonaria angustifolia—1′ HT, brilliant blue flowers in spring, dark green narrow lance-shaped leaves,. 9, 21, 27, 29, 34, 37, 49, 83, 109, 133, 137, 145, 153, 159

'Johnson's Blue'—8″ HT, blue flowers. 9

Pulmonaria montana (arenaria and *rubra)*—1′ HT, coral flowers in early spring, soft hairy long light green leaves. 3, 9, 37, 54, 83, 91, 107, 145

'Salmon Glow'—salmon flowers. 95, 159

Pulmonaria officinalis 'Cambride Blue'—10″ HT, light blue flowers in spring, heart-shaped spotted leaves. 34

Pulmonaria saccharata (picta)—1′ HT, pink and blue flowers in spring, long elliptic spotted silver leaves. 67, 95

'Alba'—white flowers, mottled leaves. 159

'Highdown'—azure-blue flowers, pink in bud, mottled leaves. 34

'Janet Fisk'—blue flowers, heavily mottled silver. 9

'Mrs. Moon'—blue flowers, green leaves with large silver spots. 9, 21, 27, 29, 37, 39, 49, 83, 91, 95, 121, 133, 137, 143, 144, 159

'Pink Dawn'—pink flowers, mottled silver leaves. 159

'Roy Davidson'—sky blue flowers, evenly mottled silver leaves. 34

Pyrola *rotundifolia americana*—1′ HT, white fragrant flowers in summer, round shiny green paddlelike leaves, requires acid humus-rich soil. 37

Ramonda *myconi*—6″ HT, lavender flowers in late spring, dark green wrinkled rosettes of leaves, requires cool rich humus-rich soil. 133

Rehmannia *glutinosa*—10″ HT, purple-brown flowers in spring, oval irregular toothed leaves. 173

Rodgersia *aesculifolia*—4′ HT, small cream-pink flowers in fluffy clusters in summer, compound broad crinkled bronze-tinted leaves, requires wet humus-rich soil. 9, 91, 107, 171

Rodgersia pinnata—4′ HT, pink flowers in midsummer, bronze foliage in spring, burnished compound crinkled foliage, requires wet humus-rich soil. 9, 29, 144, 169

'Alba'—white flowers. 9

'Superba'—darker pink flowers in midsummer. 39, 83, 159, 171

Rodgersia sambucifolia—3′ HT, creamy white sprays of flowers in summer, leaves similar to *R. pinnata* but narrower, requires wet humus-rich soil. 9, 91

Rodgersia tabularis (Astilboides tabularis)—3′ HT, creamy white flowers in summer, large circular peltate light green leaves. 9, 52, 83, 91, 165

Sagina *subulata (Spergula pilifera)*—1″ HT, small white flowers in summer, mosslike dark green leaves in dense spreading mats, evergreen, requires moist soils. 4, 52, 67, 133, 143, 159, 161, 169, 171

'Aurea'—greenish yellow leaves. 83

Sanguinaria *canadensis*—9″ HT, white cuplike flowers in spring, lobed umbrellalike leaves, prefers moist humusy soils. 9, 11, 25, 29, 37, 45, 66, 77, 83, 91, 117, 120, 137, 139, 143, 144, 145, 157, 173

'Flora Plena' ('Multiplex')—double white flowers. 29, 121, 137, 139, 143

Sanguisorba *canadensis*—6′ HT, white bottle-brush flower spikes in fall, compound toothed leaves, requires moist to wet soils. 37, 123

Sanguisorba obtusa (Poterium obtusum)—4′ HT, rose-pink flowers, compound toothed gray leaves, requires moist soils. 21, 37, 95, 107

Saxifraga: prefer north or east exposure and shelter from all-day sun, require excellent drainage and prefer stony limestone soils mixed with leaf mold.

Saxifraga 'Amitiae'—2″ HT, pastel lilac to white flowers in early spring, tiny cushionlike rosettes of leaves, requires protection from winter moisture. 145

Saxifraga x *andrewsii*—10″ HT, flesh-colored flowers on red stems, leathery encrusted strap shaped rosettes. 5, 133, 145

Saxifraga androsacea integrifolia—10″ HT, white panicles of flowers, narrow silver edged leaves in rosettes. 145

Saxifraga x *apiculata*—3″ HT, primrose yellow flowers in early spring, thin oblong pointed leaves in rosettes, requires protection from winter moisture. 133, 145

Saxifraga x *arendsii*—6″ HT, red flowers. 52

'Blood Carpet'—blood-red flowers. 159

'Farbenkissen'—red, white or rose flowers. 83

'Snow Carpet'—white flowers. 159

Saxifraga x *biasolettii*—6″ HT, reddish purple flowers in spring, gray-green narrow leaves in overlapping rosettes. 145

Saxifraga boydii 'Hindhead'—3″ HT, soft yellow flowers in early spring, dense tiny rosettes of leaves. 145

Saxifraga caespitosa 'Purple Rose'—6″ HT, rosy purple flowers in spring, mossy green cleft leaves in rosettes, evergreen. 49, 107

Saxifraga callosa—5″ HT, upfacing white flowers in arching stems in summer, narrow silver spoon-shaped leaves. 133, 145

latoscana 'Superba'—stiffly curving encrusted rosettes of leaves. 133

Saxifraga 'Carmen'—3″ HT, honey yellow flowers with reddish bases in early spring, tight green rosettes of leaves. 145

Saxifraga 'Carnival'—3″ HT, dark pink flowers in spring fading to light pink, glossy dissected rosettes of evergreen leaves. 133

Saxifraga 'Clarissa'—3″ HT, white flowers on red stems in spring, pale green needlelike rosettes. 145

Saxifraga cochlearis—8″ HT, large white flowers in summer, rosettes of silvery star-shaped leaves. 133, 145

'Minor'—6″ HT, smaller flowers with dense small silvery rosettes. 145

Saxifraga cortusifolia fortunei—6″ HT, white flowers in late summer, fleshy orbicular green leaves in rosettes, requires moist humus-rich soil. 159

Saxifraga crustata—1′ HT, white flowers with a purplish tinge in summer, small lime encrusted leaves. 133

Saxifraga x *engleri*—6″ HT, white flowers in summer, gray narrow strap-shaped leaves in rosettes. 145

Saxifraga 'Faldonside'—3″ HT, lemon-yellow flowers in early spring, blue-green cushionlike rosettes. 133

Saxifraga 'Four Winds'—5″ HT, red flowers in spring, soft shiny evergreen dissected leaves. 133

Saxifraga x *geum*—1′ HT, white flowers in spring, large oblong leaves with ribbed leaf margins. 133

Saxifraga 'G.M. Hopkins'—3″ HT, white single flowers in early spring, tight cushionlike leaves. 145

Saxifraga granulata—1.5′ HT, large white flowers in spring, lobed kidney-shaped leaves, short lived perennial. 161

'Plena'—double flowers. 121

Saxifraga hostii—2′ HT, white flower clusters in summer, linear pointed leathery rosettes of leaves turning red in fall. 145

Saxifraga hypnoides—6″ HT, white flowers in spring, soft green linear lobed leaves in rosettes, evergreen. 133

Saxifraga jenkinsii—2″ HT, pink saucers in early spring, glaucous gray cushionlike rosettes. 145

Saxifraga juniperifolia sancta—3″ HT, yellow flowers in early spring, emerald green stiff lance-shaped leaves in rosettes. 145

Saxifraga x *kellereri*—6″ HT, pink flower clusters in spring, gray overlapping rosettes of leaves. 145

Saxifraga 'Kingscote White'—4″ HT, large white flowers in spring, evergreen downy rosettes of leaves. 133

Saxifraga 'Kinlayi'—6″ HT, gray green encrusted rosettes. 145

Saxifraga 'L.C. Godseff'—3″ HT, lemon-yellow flowers in early spring, spiny blue-green rosettes of leaves. 133, 145

Saxifraga x *macnabiana*—18″ HT, white flowers spotted with purple in summer, wide green rosettes of leaves. 145

Saxifraga moschata—5″ HT, white or pale creamy yellow flowers in early spring.

'Compacta'—1″ HT, white flowers, soft evergreen finely cut leaves. 145

'Variegata'—5″ HT, variegated leaves. 133

Saxifraga 'Opalescent'—3″ HT, pale yellow flowers in early spring, grayish tight mounds of leaves. 145

Saxifraga paniculata (aizoon)—20″ HT, pale yellow flowers marked with purple in summer, dense rosettes of narrow spoon-shaped encrusted leaves.

'Balcana'—white flowers with red spots. 133

'Brevifolia'—white flowers. 133, 145

'Cockscomb'—leaves encrusted on leaf center. 133

'Foster's Red'—deep red flowers. 133

'Minutifolia'—white flowers, minute gray rosettes. 145

'Rex'—large white flowers with red stems, large green leaves with a silver edge in rosettes. 145

'Rosea'—bright pink flowers. 133

Saxifraga x *paulinae*—2″ HT, pale yellow flowers in early spring, compact cushionlike plants with silvery leaves. 145

Saxifraga pensylvanica—3′ HT, greenish flowers, prefers boggy soil. 120

Saxifraga 'Perle Rose'—3″ HT, pink flowers in early spring, tight rosettes of leaves forming a rounded dome. 145

Saxifraga 'Peter Pan'—3″ HT, crimson flowers in spring, dark green scalloped rosettes of leaves. 133, 145

Saxifraga porophylla sibthorpiana—6″ HT, dark purple calyces covering nodding pale purple flowers in spring, finely pointed silvery leaves in overlapping rosettes. 145

Saxifraga x *salomonii*—2″ HT, white flowers with red buds in early spring, sprawling rosettes of silvery blue leaves. 145

Saxifraga stolonifera (sarmentosa)—2′ HT, delicate white flowers, fleshy leaves with a reddish undersurface sending out runners with new plantlets, tender. 41, 54, 109, 137, 183

Saxifraga taygetea—10″ HT, white flowers spotted with purple, fleshy dark green leaves. 145

Saxifraga trifurcata—8″ HT, creamy white flowers in spring, evergreen mats of bright

green leaves standing erectly. 133, 153

Saxifraga 'Triumph'—6″ HT, red flowers in spring, divided green leaves. 133

Saxifraga umbrosa (primuloides)—1′ HT, small pink or white flowers in late spring, funnel-form rosettes of large long pointed leaves becoming tumbling mounds, requires humus-rich soil.

'Aurea Punctata'—deep green smooth rosettes of leaves splashed with gold. 133

'Elliot's Variety'—8″ HT, hanging rose-pink flowers. 159, 161

Saxifraga x *urbium*—18″ HT, white or pink flowers in spring, large pointed leaves. 3, 37

'Primuloides'—8″ HT, pale pink flowers. 145

'Primuloides Nana'—5″ HT, creamy white flowers. 145

Saxifraga veitchiana—white flowers, rounded fleshy leaves. 54, 133, 173

Saxifraga 'White Hill'—4″ HT, creamy white flowers in summer, metallic blue tufts of leaves flushed red at the base in rosettes. 133, 145

Saxifraga 'White Pixie'—2″ HT, white flowers, soft bright green divided leaves.

Saxifraga 'Winifred Bevington'—8″ HT, red and white flowers in summer, small green scalloped leaves edged in silver. 133, 145

Sedum ternatum—4″ HT, bluish white flowers in late spring, small rounded leaves in threes, evergreen, rhizomatous. 66, 67, 109, 117, 144, 157, 173

'Seneca Rock'—11

'White Waters'—more floriferous. 37, 133, 183

Selaginella: are nonflowering plants grown for their foliage, require moist well drained soils and have spiky mosslike leaves.

Selaginella 'Eco Mt. Emei'—6″ HT, tufted lacy gold green mosslike fans, tender. 54

Selaginella involvens (braunii)—1′ HT, jade-green lacy stems turning brown in fall. 41, 181

Selaginella sanguindentata compressa—2″ HT, wiry stems with zigzag green leaves, tender. 145

Selaginella uncinata—prostrate blue-green leaves, tender. 181

Shortia galacifolia—8″ HT, delicate white bell-shaped flowers in spring fading to pink, evergreen, oval shiny leaves tinged with bronze, requires acid humusy soil. 9, 21, 37, 66, 133, 139, 144

Smilacina racemosa—3′ HT, white fragrant flowers in late spring, lance-shaped blue-green leaves, red berries in fall, rhizomatous, requires moist humusy soils. 21, 25, 29, 37, 61, 66, 83, 120, 123, 139, 143, 173

Smilacina stellata—1′ HT, white flowers in late spring, red berries in fall, tolerates dry soil. 25, 139

Smilacina trifolia—6″ HT, white flowers in spring, small lance-shaped leaves, red berries in fall, requires moist boggy soils. 120

Soldanella cynaster—6″ HT, purple-blue flowers in early spring, requires moist humusy soil. 145

Soldanella hungarica (carpatica)—5″ HT, purple fringed pendulous flowers in early spring, requires moist humus-rich soil. 145

'Alba'—white flowers. 145

Soldanella montana—15″ HT, violet fringed pendulous flowers in early spring, requires moist humus-rich soil and good drainage. 139

Spigelia marilandica—2′ HT, slender starlike trumpet flowers in early summer, scarlet outside and soft yellow inside, shiny lance-shaped leaves, rhizomatous. 37, 113

Stellaria pubera—1′ HT, showy white notched flowers in spring, lanceolate hairy leaves, requires rich moist soil. 54, 109

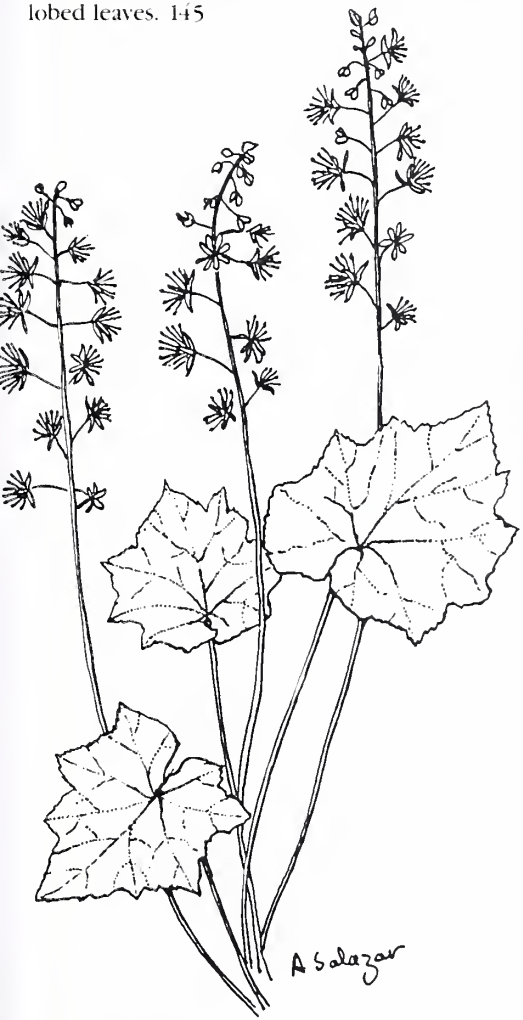
Symphytum caucasicum—3′ HT, pink to azure-blue tubular flowers in summer, coarse hairy leaves, prefers moist soil. 153

Symphytum grandiflorum (Pulmonaria lutea)—8″ HT, pale yellow tubular flowers in spring, hairy coarse oblong leaves in spring, prefers moist soil. 9, 37, 49, 61, 65, 77, 95, 139, 153, 159, 165, 173

Symphytum rubrum—1.5′ HT, tubular crimson flowers in early summer, dark green hairy leaves. 9, 37, 65, 153

Symphytum x *uplandicum (peregrinum)*—4′ HT, tubular pink flowers in bud opening to blue in late spring, coarse oval leaves. 9

Synthyris *missurica*—1′ HT, large pink bells in early spring, evergreen mounded finely lobed leaves. 145



Tiarella cordifolia

Synthyris reniformis—4′ HT, small purple bells in early spring, evergreen lobed leathery leaves, tolerates dry shade. 133, 139, 145

Synthyris stellata—1′ HT, purple spikes in early spring, evergreen rounded notched leaves. 145

Thalictrum *clavatum*—1′ HT, white fluffy flowers in spring, finely divided leaves, requires moist soil. 173

Thalictrum coreanum—1′ HT, pink powderpuff flowers in late spring, olive-green rounded leaves on wiry stems, requires moist soil. 54, 133, 145, 173

Thalictrum dioicum—2.5′ HT, small greenish hairy flowers in spring, drooping columbine-like leaves, requires moist to wet soil. 25, 45, 66, 120, 139

Thalictrum fendleri—3.5′ HT, green loose panicles of flowers in midspring, finely divided leaves, prefers moist soil. 97

Tiarella *cordifolia*—1′ HT, white loose flower spikes in midspring, semievergreen maplelike leaves with a reddish fall color, stoloniferous, requires moist humus-rich soil. 9, 21, 29, 37, 49, 66, 77, 83, 109, 113, 115, 121, 123, 133, 139, 144, 159

Tiarella polyphylla—8″ HT, white delicate panicles of flowers, rounded shallowly lobed leaves, stoloniferous. 173

Tiarella wherryi—8″ HT, pink loose flower spikes in spring, semievergreen, red-veined maplelike leaves, clump forming. 3, 9, 37, 54, 83, 133, 143, 145, 159, 169, 173, 175

Tolmiea *menziesii*—2′ HT, small greenish white flowers in spring, hairy heart-shaped maplelike leaves with plantlets forming at the leaf base, tender. 139

Tradescantia *subaspera*—2′ HT, small blue flowers in early summer, narrow rounded lance-shaped leaves, requires moist humus-rich soil. 37, 109, 173

Tricyrtis: prefer moist humus-rich soil, are rhizomatous, have flowers which are small and star-shaped with prominent stamens and

styles, bloom in the fall, and leaves which are lance-shaped on arching stems.

Tricyrtis flava—15″ HT, lemon yellow flowers dusted with purple spots. 173

Tricyrtis formosana—3′ HT, dark maroon flower buds open to mauve-brown, tender. 34, 159, 171

'Amethystina'—3′ HT, amethyst-blue and white flowers speckled with dark red. 171

Tricyrtis hirta—2.5′ HT, white spotted lilac flowers born in leaf axils instead of terminal clusters.

'Alba'—pure white flowers. 109, 145, 173

'Miyazaki'—white spotted lilac flowers. 9, 37, 122, 143, 159, 171, 173

'Variegata'—variegated leaves. 9, 145

'White Towers'—pure white flowers. 34

Tricyrtis latifolia—2′ HT, yellow spotted purple flowers in summer. 11, 49, 145, 173

Tricyrtis macrantha—1.5′ HT, pendulous golden yellow flowers in summer with brown spots. 159

Tricyrtis macropoda—2.5′ HT, greenish yellow or cream flowers with purple spots. 173

Tricyrtis puberula—1.5′ HT, yellow flowers with brown spots in summer. 37, 133

Tricyrtis 'Sinonome'—1.5′ HT, showy pale purple flowers heavily spotted with deep purple. 109, 173

Trientalis borealis (americana)—10″ HT, white delicate star-shaped flowers in early summer, lance-shaped clusters of leaves at the tops of the stems. 120, 139

Trientalis latifolia—10″ HT, white flowers similar to *T. borealis*, but with oval leaves. 139

Trillium: require rich moist well-drained acid soils. They have single stems bearing whorled leaves in threes and bloom in the spring.

Trillium catesbaei (stylosum)—10″ HT, pink flowers with yellow anthers held under the leaves. 37, 66, 139, 145, 173

Trillium cernuum—1.5′ HT, white flowers nodding under leaves. 25, 66, 120, 139, 144, 145

Trillium chloropetalum 'Giganteum'—1.5′ HT, deep velvety maroon flowers, dark green mottled gray leaves. 145

Trillium cuneatum—1′ HT, broad maroon fruit-scented flowers, dark green mottled gray leaves. 173

Trillium erectum—15″ HT, clear maroon, purplish, greenish purple flowers with indigo centers and a foul scent, rich green leaves. 37, 45, 66, 121, 133, 139, 143, 145, 159, 173

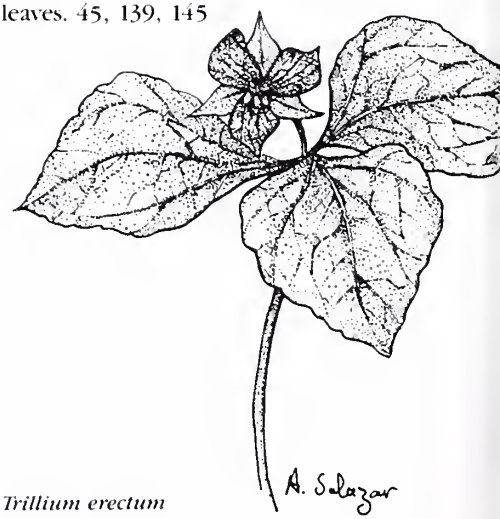
albiflorum—white flowers. 66, 133, 139, 173

luteum—pale yellow flowers. 139

Trillium grandiflorum—1.5′ HT, large pure white flowers fading to blush pink, broad green leaves. 9, 21, 25, 29, 37, 45, 66, 120, 122, 133, 137, 139, 143, 145, 159, 171, 173

Trillium kamtschaticum—1′ HT, white flowers. 139

Trillium ovatum—1′ HT, large pure white flowers fading to pink, broad overlapping leaves. 45, 139, 145



Trillium erectum

Trillium pusillum—8″ HT, white flowers fading to pink or purple, oblong leaves. 139

Trillium recurvatum—1.5′ HT, brownish purple flowers, broad elliptic leaves mottled purple. 133, 139, 145, 173

Trillium rivale—8″ HT, white flowers marked with rose and carmine, oblong lanceolate leaves, requires gritty sandy soil. 11, 45, 139, 145

Trillium sessile—1′ HT, maroon, yellow to white fragrant flowers, oval mottled leaves. 29, 37, 45, 66, 137, 139, 143, 145

'Luteum'—yellow lemon-scented flowers. 37

Trillium undulatum—1.5′ HT, white wavy petals with delicate red central halo, oval pointed bronze-red leaves changing to deep green, requires cool temperatures and more acid soils. 9, 37, 66, 139, 143

Trillium viride luteum—1′ HT, yellow or greenish lemon-scented flowers, mottled lance-shaped leaves. 45, 66, 133, 137, 139, 143, 145, 173

Uvularia caroliniana (pudica)—10″ HT, pale yellow bellflowers in spring, glossy green leaves, rhizomatous, prefers moist humus-rich soils. 173

Uvularia grandiflora—2′ HT, drooping straw-yellow bellflowers in spring, fresh green oblong leaves, rhizomatous, requires moist humus-rich soils. 9, 25, 37, 66, 139, 143, 145

Uvularia perfoliata—1.5′ HT, pale yellow bells in spring held above the oblong leaves, rhizomatous, prefers moist humus-rich soils. 21, 37, 54, 66, 77, 107, 120, 139, 145, 173

Uvularia sessilifolia—1′ HT, narrow tubular creamy bells in spring, oblong lanceolate brownish leaves turning green, rhizomatous, requires moist humus-rich soils. 37, 49, 66, 120, 139, 143, 144

Vancouveria chrysantha—1′ HT, small golden yellow flowers in spring, small leathery evergreen leaves, rhizomatous, requires moist humus-rich soils. 54

Vancouveria hexandra—6″ HT, white flowers in late spring, small rounded lobed leaves, rhizomatous. 9, 133, 137, 139, 144, 145

Vancouveria planipetala—1′ HT, white flowers with lavender eyes in late spring, small rounded lobed leaves, semievergreen groundcover. 139

glaucophylla—glaucous leaves. 54

Vinca major—8″ HT, bright blue flowers in spring, shiny oval leaves on trailing stems, evergreen, tender. 171

'Morning Glory'—large purple-blue flowers. 65, 153

'Variegata'—leaves variegated with creamy white. 65

Vinca minor—8″ HT, lilac-blue flowers in spring, small oval dark shiny green leaves, evergreen groundcover. 3, 27, 37, 63, 66, 67, 75, 91, 97, 122, 133, 169, 171, 183

'Alba'—white flowers. 9, 27, 37, 67, 83, 95, 159, 171, 177

'Atropurpurea'—reddish purple flowers. 67

'Bowles Variety'—light blue flowers, grows in clumps. 9, 27, 37, 65, 67, 83, 95, 97, 133, 144, 153, 169, 171, 177

'Flore Pleno' (*Vinca alpina*)—double purple-blue flowers. 34, 95, 133, 153

'Flowing Gold'—new growth is a soft gold. 34

'Miss Jekyll's White'—4″ HT, smaller white flowers, smaller leaves. 9, 34, 37, 65, 83, 95, 133, 153, 161, 169

'Purpurea' ('Burgundy')—wine-red flowers. 37, 83, 95

'Sterling Silver'—dark green leaves speckled with light green and cream margins. 37, 159

'Variegata'—blue flowers, leaves variegated with yellow. 34, 37, 83, 95, 144, 169, 183

Viola canadensis—1′ HT, white fragrant flowers with a yellow eye and tinged with vio-

let in spring, small heart-shaped leaves. 63, 66, 83, 139, 181

rugulosa—wider leaves, stoloniferous. 120

Viola pubescens—1′ HT, yellow flowers in spring with purple veins, pubescent leaves. 21, 37, 63, 83, 120, 139, 171

eriocarpa (pensylvanica)—6″ HT, smooth leaves. 181

Viola rotundifolia—6″ HT, pale golden flowers. 9, 37, 66, 139

Ferns

***Adiantum** capillus-veneris*—2′ HT, bright green leaves with black stem, prefers shade, tender. 54, 157, 181

Adiantum caudatum—1.5′ HT, prefers shade, tender. 54

Adiantum pedatum—2′ HT, fine textured dark green leaves with a black stem, prefers shade. 9, 25, 29, 37, 43, 45, 49, 66, 77, 91, 95, 113, 120, 133, 139, 143, 145, 157, 173

aleuticum—6″ HT, dwarf form. 159

'Miss Sharples'—2′ HT, grayish tomentose fronds. 159

subpumilum—6″ HT, dwarf form. 139, 145

Adiantum venustum—2′ HT, small round bright green leaflets.

***Arachniodes** aristata* 'Variegatum'—2′ HT, faintly variegated edges. 145, 159

***Asplenium** platyneuron*—1′ HT, evergreen. 9, 37, 43, 66, 133, 139, 143, 159, 173.

Asplenium resiliens—dainty evergreen. 41

Asplenium trichomanes—8″ HT, evergreen. 43, 139, 145

***Asplenosorus** x ebonoides (Asplenium platyneuron* x *Camptosorous rhizophyllus)*—1′ HT, lobed fronds with long tips. 49, 139, 143, 145, 157, 159

***Athyrium** distentifolium*—8″ HT, erect bright green fronds, stoloniferous. 145

Athyrium felix-femina—2′ HT, lacy fronds, invasive. 25, 29, 37, 43, 49, 77, 91, 95, 120, 139, 143, 159, 173, 181.

asplenioides—2.5′ HT, evergreen, aggressive spreader. 173

'Congestum Cristatum'—1′ HT, thick stems, wide crested fronds. 145

'Minutissima'—5″ HT, soft green deeply cut fronds. 83, 145

'Plumosum Cristatum'—1.5′ HT, plumed and crested. 159

rubella—120, 157

'Veroniae Cristatum'—2′ HT, graceful with tassels. 37, 41, 57, 139, 145

'Victoria'—2′ HT, pinnae grow in different directions. 41, 139

Athyrium goeringianum (nipponicum)

'Gloriosa'—95

'Gurgedyke'—95

'Lamb's Brilliant'—95

'Metall'—83

'Pictum'—1.5′ HT, maroon stems, gray fronds. 9, 29, 37, 41, 45, 49, 61, 77, 95, 133, 139, 143, 145, 157, 159, 165, 181

'Pictum Red'—1.5′ HT, more reddish tone in fronds. 9

Athyrium otophorum—1.5′ HT, leathery maroon stems, bluish gray fronds. 37, 41, 54, 61, 139, 143, 145

'Okanum'—2′ HT, bronze stems, silvery fronds. 159

***Blechnum** penna marina*—4″ HT, brownish-green fronds, stoloniferous. 145

Blechnum spicant—1.5′ HT, erect, horizontal fronds. 139, 181

***Botrychium** virginianum*—1.5′ HT, lacy fronds, spore cases resemble grape bunches. 43, 66, 120, 139, 173.

***Camptosorus** rhizophyllus*—8″ HT, undivided green leaves, roots at tips to produce new plants. 37, 43, 83, 133, 139, 143, 173

Cheilanthes *feei*—12″ HT, densely woolly leaves. 133

Cheilanthes gracillima—12″ HT, densely woolly leaves, dark brown petioles. 145

Cheilanthes lanosa (tomentosa)—8″ HT, finely divided hairy fronds, can tolerate full sun. 133, 159, 173

Cheilanthes siliquosa—18″ HT, triangular shaped leaves. 145

Cryptogramma *crispa*—5″ HT, spiky fertile fronds, ruffled bright green sterile fronds. 133, 145

Cyrtomium *falcatum*—2′ HT, dark shiny green leathery broad fronds, resembles holly leaves, tender. 41

'Rockfordii'—159

Cyrtomium fortunei—2′ HT, dull leathery sickle-shaped leaves. 41, 83

Cystopteris *bulbifera*—1.5′ HT, long tapering fronds, bulbils drop off forming new plants, rhizomatous. 43, 66, 133, 139, 143, 157, 173

Cystopteris dickeana—3″ HT, pale green tightly packed fronds. 145

Cystopteris fragilis—6″ HT, lacy, light green delicate fronds, rhizomatous. 139, 145

Cystopteris protusa—10″ HT, lacy pale green delicate fronds, southern counterpart to *C. fragilis*, rhizomatous. 54, 173, 181

Dennstaedtia *punctilobula (Dicksonia punctilobula)*—2′ HT, finely dissected fronds of bright green, extremely invasive. 9, 21, 41, 43, 83, 91, 139, 143, 159, 171, 173, 177

Diplazium *acrostichoides (Athyrium thelypteroides)*—3′ HT, deeply lobed fronds with toothed leaflets and straw-colored petioles. 43, 139

Dryopteris *affinis*—1.5′ HT, semievergreen to evergreen, golden-green with orange shag on stipe, prefers moist soil. 145

'Crispa'—edges "crisped." 159

Dryopteris arguta—1′ HT, shiny leaves, prefers moist soil. 139, 145

Dryopteris atrata—1.5′ HT, wide dark green fronds coarsely serrate, prefers moist soil. 9, 41, 49, 139, 143, 145, 159

Dryopteris austriaca spinulosa—2.5′ HT, rich dark green finely cut fronds, prefers moist soil. 25, 37, 43, 66, 83, 113, 120, 122, 139, 143, 159, 171, 177

Dryopteris borreri 'Crispa'—1′ HT, parsleylike fronds, prefers moist soil. 159

Dryopteris cristata—3′ HT, semievergreen to evergreen, narrow leathery fronds, prefers moist soil. 43, 83, 91, 120, 139, 143, 159, 177

Dryopteris dilatata—

lepidota 'Cristata'—1.5′ HT, vase-shaped fronds dark green and crested, very lacy. 9, 41, 54, 61, 139, 143, 145, 159

recurvata—2′ HT, semievergreen fronds arching with curly leaflets. 9, 41, 61, 139, 143, 145, 159

Dryopteris erythrosora—2′ HT, evergreen glossy fronds, broad triangular toothed, coppery-pink new growth in spring, prefers moist soil. 9, 21, 41, 43, 77, 83, 139, 143, 145, 159, 171, 173, 181

'Prolifica'—10″ HT, more finely divided fronds. 173

Dryopteris filix-mas—3′ HT, semievergreen divided fronds, very tolerant of dry shade. 9, 66, 139

'Barnesii'—139

'Crispa Cristata'—ruffled leaflets. 139, 143, 145

linearis polydactyla—3.5′ HT, graceful with slender fronds and crested leaflets. 9, 41, 139, 145, 159

undulata robusta—rich green wavy fronds. 49, 61, 139, 143, 145

Dryopteris goldiana—3.5′ HT, yellowish fronds in spring turning green in summer, large

boldly divided fronds, prefers moist soil. 9, 37, 43, 49, 66, 83, 139, 143, 157

Dryopteris ludoviciana—3′ HT, evergreen fronds, prefers moist soil. 41, 181

Dryopteris marginalis—2.5′ HT, semievergreen, dark green leathery fronds, prefers moist soil. 9, 21, 29, 37, 43, 66, 83, 91, 95, 97, 107, 113, 139, 143, 157, 159, 177

Dryopteris wallichiana—4.5′ HT, golden-green unfolding fronds, shiny green mature fronds with brownish gray scaly hairs on stem. 41, 61, 83, 139

Gymnocarpium *dryopteris (Dryopteris disjuncta* and *linnaeana)*—6″ HT, delicate thin triangular leaflets, rhizomatous. 91, 120, 145

Gymnocarpium robertianum—1′ HT, thicker foliage and duller green than *G. dryopteris,* rhizomatous. *145*

Lygodium *japonicum*—10″ HT, triangular light green lacy leaves, twining stems, tender. 41, 54

Marsilea *quadrifolia*—floating cloverlike leaves, requires wet soils or a pond, may be a weed. 173

Matteuccia *pensylvanica (Pteretis nodulosa)*—6′ HT, shuttlecock arrangement of fronds, soft gray lacy leaves, rhizomatous, requires moist to wet soil. 21, 49, 66, 83, 91, 97, 107, 120, 137, 143, 177

Matteuccia struthiopteris—3′ HT, shuttlecock arrangement of fronds, soft gray lacy leaves, rhizomatous, stems less erect than *M. pensylvanica*, requires moist to wet soil. 25, 29, 37, 43, 83, 133, 139, 159, 171

Microlepia *strigosa (speluncae)*—3′ HT, leaves erect, finely dissected, tender. 83

Onoclea *sensibilis*—2′ HT, larger bold arching finely dissected leaves, sends up fronds all summer, invasive. 21, 25, 29, 37, 41, 43, 45, 66, 83, 120, 139, 143, 159, 177

Osmunda *cinnamomea*—4′ HT, unfurling lacy fronds covered with cream-brown woolly down, separate fertile cinnamon colored fronds, requires moist to wet soil. 9, 21, 25, 37, 41, 43, 66, 77, 83, 91, 137, 139, 143, 144, 159, 171, 177

Osmunda claytoniana—4′ HT, lacy fronds interrupted with a brown fertile area, requires moist to wet soil. 21, 25, 29, 37, 43, 66, 83, 91, 107, 120, 139, 143, 159

Osmunda regalis—4′ HT, leaves tinted coppery brown when unfurling, brown fertile fronds, gray-green lacy sterile fronds turning yellow-brown in autumn. 9, 21, 25, 41, 43, 49, 66, 83, 91, 107, 113, 139, 143, 159, 181

Pellaea *atropurpurea*—1′ HT, gray elongated leaves with dark purple hairy stems, requires moist soil. 133, 139, 145,

Phyllitus *scolopendrium*—1.5′ HT, broad leathery leaves, strap-shaped fronds. 49, 83, 113, 139, 143, 145, 159, 173

'Cristatum'—crested wavy tips. 159

'Laceratum Kaye'—tasseled form, irregulary cut and indented fronds. 41, 143, 145, 159

Polypodium *glycyrrhiza*—18″ HT, triangular shaped leaves. 145

Polypodium malahatense—10″ HT, light bright green deeply cut fronds with jagged pointed leaflets. 145

Polypodium scouleri—1.5′ HT, large leathery dark green fronds, tender. 145

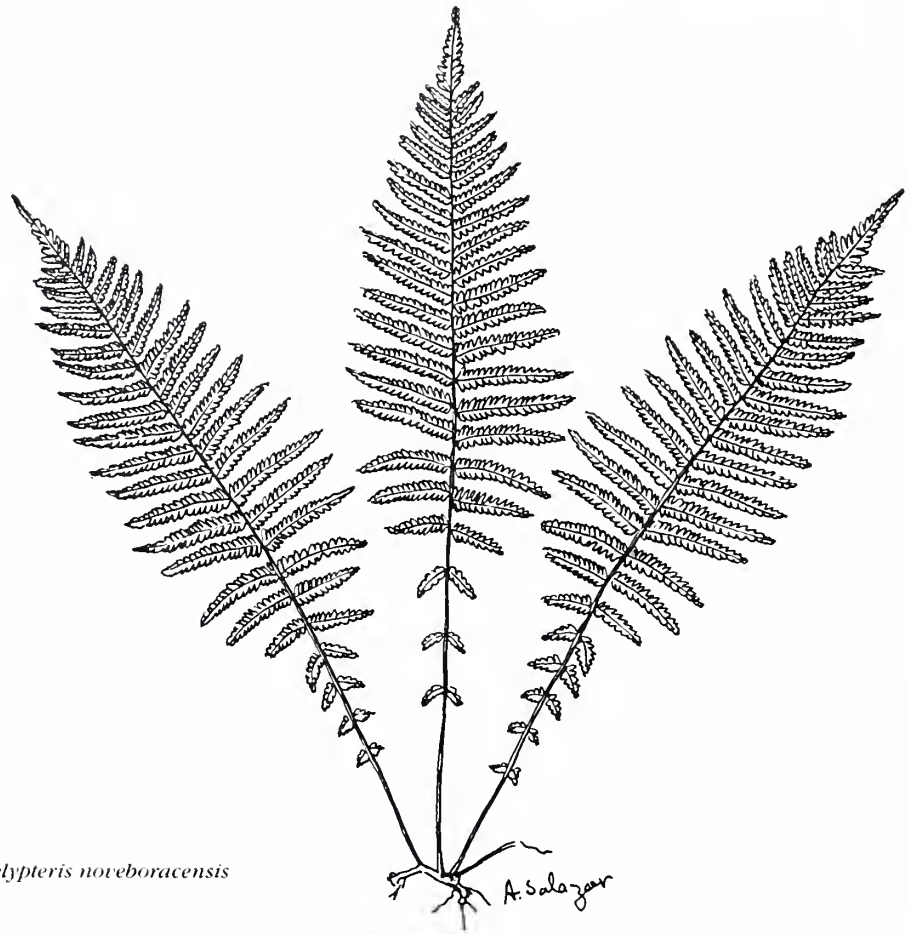
Polypodium vulgare—10″ HT, evergreen lacy leaflets, rhizomatous, tolerates dry soil. 37, 43, 66, 83, 139

bifidum—soft green fronds with divided stripe. 145

comubiense—most dissected form with golden-green fronds. 139, 145

cristatum—crested fronds. 145

Polystichum *acrostichoides*—2′ HT, dark green evergreen leaves, tolerates full sun with



Thelypteris noveboracensis

damp soil conditions. 9, 21, 25, 29, 37, 41, 43, 45, 49, 61, 66, 67, 77, 83, 91, 95, 107, 181

'Incisum'—leaflets deeply cut. 41

Polystichum aculeatum—2′ HT, narrow fronds. 83, 95, 181

Polystichum andersonii—2′ HT, narrow fronds, small plantlets are produced on frond tips. 145

Polystichum braunii - 2′ HT, fronds with oblong leaflets, spine tipped and toothed. 9, 41, 43, 83, 139, 143, 159

Polystichum munitum—3.5′ HT, fronds leathery, evergreen and toothed. 61, 83, 91, 139

imbricans—10″ HT, overlapping leaflets. 83, 145

Polystichum polyblepharum—3′ HT, deep green shiny fronds with silvery undersides, tasseled. 49

Polystichum setiferum—2.5′ HT, soft dark green fronds with feathery leaflets, tolerant of dry shade. 171

'Plumosum Densum'—each leaflet is doubled. 83

***Pteridium** aquilinum*—4′ HT, fronds up to 3′ wide, rhizomatous. 66, 83, 120

***Pteris** multifida*—1′ HT, leaflets long and narrow, lower leaflets forked, upper stem is winged, tender. 41, 181

***Pyrrosia** lingua*—1′ HT, fronds thick, scaly lance-shaped, rhizomatous, evergreen in the south.

'Variegata'—fronds streaked with yellow and green. 54

Thelypteris *decursive-pinnata*—1′ HT, delicate lacy fronds, rhizomatous, requires moist humus-rich soil. 181

Thelypteris hexagonoptera (Dryopteris hexagonoptera)—15″ HT, wide trinagular lacy fronds, rhizomatous, requires humus-rich soil. 21, 37, 43, 66, 173

Thelypteris kunthii—1.5′ HT, large narrow lacy fronds, requires moist to wet soils, tender. 173, 181

Thelypteris noreboracensis (Dryopteris noreboracensis)—2′ HT, greenish yellow lacy fronds, tolerates full sun, requires moist to wet soil. 21, 37, 43, 66, 91, 120, 139

Thelypteris palustris (Dryopteris palustris)—2′ HT, dainty erect fronds, requires moist to wet soil. 37, 43, 66, 83, 91, 120, 139

Thelypteris phegopteris (Dryopteris phegopteris)—2′ HT, medium green narrow triangular fronds, requires moist soil. 37, 120, 139

Woodsia ilvensis—10″ HT, narrow green silvery fronds with thick hairs turning rust color in fall, tolerant of dry acid soil. 43, 133, 143

Woodsia obtusa—10″ HT, finely cut fronds becoming yellow green in the sun, tolerates full sun, prefers alkaline soil. 173

Woodsia oregana—6″ HT, tufted finely dissected fronds, prefers alkaline soil. 145

Woodwardia areolata—15″ HT, bronze-red narrow fronds turning yellow-green with a golden fall color, prefers moist to wet acid soil. 41, 181

Woodwardia virginica—3′ HT, glossy dark green fronds, tolerant of full sun, prefers wet acid soil. 37, 66, 83, 173

Ornamental Grasses and Bamboos

Alopecurus *pratensis aureus*—1′ HT, golden foliage, purple green flowers in spring. 27, 91

Andropogon *gerardii*—5′ HT, leaves glaucous with blue stems, red orange fall color. 49, 91, 127, 159, 161, 165

Anthoxanthum *odoratum*—2′ HT, brownish-yellow flowers in summer, leaves fragrant. 69

Arrhenatherum *elatius*

bulbosum—1′ HT, pale green flowers in summer, green leaves. 133, 139, 169

'Variegatum'—leaves variegated with white markings. 9, 91, 143

Arundinaria *gigantea tecta*—15′ HT, requires sun. 66

Arundinaria pumila—2′ HT, bright green leaves, tender. 83

Arundinaria pygmaea (Sasa pygmaea)—1-2′ HT, deep green leaves, sun or shade, invasive. 37, 49, 91

Arundinaria variegata—1.5′ HT, foliage green with white stripes, sun or shade. 9, 37, 159, 165

Arundinaria viridiflorus (viridistriata)—1.5′ HT, foliage green with golden stripes, sun or shade, tender. 37, 165

Arundo *donax*—8′ HT, drooping broad gray-blue leaves. 21, 91

'Variegata'—striped white and green foliage. 91, 97

Bouteloua *curtipendula*—2.5′ HT, arching

blades and flowers in summer. 91, 117, 127, 159, 165

Bouteloua gracilis—1.5′ HT, brown flowers, narrow leaves. 159, 161, 165

Briza media—1.5′ HT, green, nodding locket-shaped flowers in summer. 9, 49, 65, 91, 144, 153, 159, 161, 165

Calamagrostis x *acutiflora* 'Stricta'—4′ HT, brown plumes fading to gray in late summer, leaves stiff upright turning purplish in fall. 9, 21, 27, 65, 91, 159, 165, 171

Calamagrostis arundinacea—5′ HT, similar to above only not as upright. 9

brachytricha—3′ HT, loose airy plumes in summer, dark green leaves. 9, 21, 65, 91

'Karl Foerster'—5′ HT, narrow pink-purple plumes in summer, slender dark-green leaf blades. 9, 37, 49, 77, 83, 91, 165

Calamagrostis canadensis—6′ HT, thin, blue-green flowers in summer. 127

Carex *baldensis* -91

Carex buchananii—2′ HT, narrow bronze leaves. 3, 9, 49, 65, 91, 144, 153

Carex conica—2′ HT, light brown plumes in spring to early summer, stiff dark green leaves. 9, 139

'Hime Kansuga'—4″ HT, deep green edged leaves with narrow white stripe, prefers shade. 9, 37

'Marginata'—4″ HT, variegated foliage, prefers shade. 91

'Variegata'—8″ HT, dark green leaves with white margins, prefers shade. 21, 37, 144, 145, 159

Carex digitata—8″ HT. 91

Carex flacca—10″ HT, dense with narrow gray-green foliage. 91, 173

Carex flagellifera—3′ HT, orange foliage. 65, 91

Carex flava—91

Carex glauca—6″ HT, bright blue-gray foliage. 3, 9, 65, 91, 144, 145.

Carex grayi—2′ HT, light green thin leaves. 21, 91, 143, 159

Carex morrowii—2′ HT, dark reddish-brown leaves.

'Aurea-variegata'—15″ HT, creamy-yellow foliage with narrow green edge, evergreen, prefers shade. 9, 21, 37, 65, 91, 139, 153, 159, 171

'Evergold'—10″ HT, similar to 'Aurea-variegata' only evergreen. 91, 144

expallida ('Variegata')—1.5′ HT, foliage has white stripes in center and green edges. 54, 61

Carex muskingumensis—2′ HT, wide strap leaves, bronze fall color, prefers shade. 3, 21, 49, 91, 161, 165

Carex nigra—6″ HT, vigorous blue leaves, prefers shade. 9, 49, 91, 144

Carex ornitopoda 'Variegata'—6″ HT, softly curving stems, thin cream and green variegation. 3, 91, 133

Carex pendula—3′ HT, coarse arching green leaves. 3, 9, 21, 91, 117, 143, 159, 161

Carex pennsylvanica—1′ HT, adapted to dryer soils. 127

Carex petriei—narrow bronze leaves. 165

Carex plantaginea—10″ HT, evergreen broad leaves. 91, 173

Carex speciosa 'Velebit Humilis'—91

Carex sylvatica—6″ HT, 91, 165

Carex x 'The Beatles'—91

Carex umbrosa—91

Chasmanthium *latifolium (Uniola latifolia)*—3′ HT, large flat spikelets, green leaves, full sun or shade. 9, 21, 49, 91, 113, 143, 153, 159, 161, 165, 173, 181

Cortaderia selloana—8′ HT, white plumes in early fall, deep green narrow leaves, tender. 33, 37, 69, 83, 91, 144, 159, 169, 171

'Argentea'—8′ HT, silvery plumes. 91

'Carminea Rendadleri'—rosy-lilac plumes. 91

'Rosea'—10′ HT, pink plumes. 37, 175

'Sonningdale Silver'—feathery creamy white open plumes. 91

Cymophyllus fraseri—10″ HT, white flowers in spring, leaves straplike, evergreen, requires moist soil, prefers shade. 54, 173

Dactylis glomerata (lutea) 'Variegata'—1.5′ HT, variegated leaves. 9, 91

Deschampsia caespitosa—3′ HT, delicate green purplish flowers in summer, arching dark green leaves. 9, 21, 65, 143, 159, 161, 165

'Bronze Veil' ('Bronzeschleier')—bronze-yellow plumes. 49, 91, 143, 165

'Goldgehaenge'—golden-yellow plumes. 9, 91, 143, 165

'Golden Veil' ('Goldschleier')—bright yellow plumes. 49, 91, 165

'Goldstaub'—yellow plumes. 9, 27, 65, 91, 165

'Schottland'—5′ HT. 9, 91, 143, 165

tardiflora—3′ HT, later blooming. 9, 65, 91, 143

'Tautraeger'—delicate slender inflorescence —9, 91, 143

Deschampsia flexuosa 'Aurea'—1′ HT, golden yellow plumes in summer, shiny dense tufts of golden-green leaves. 109, 145

Deschampsia vivipara 'Fairy's Joke'—1.5′ HT, leaves thin, gray-green in tufts, blooms in summer. 9, 65, 91

Elymus arenarius—4′ HT, leaves blue-gray, straplike, rhizomatous, extremely invasive. 49, 61, 65, 83, 153

Elymus canadensis—5′ HT, grayish plumes in summer, leaves arching, glaucous. 127, 165

Elymus glaucus—4′ HT, grayish plumes in summer, glaucous leaves, upright, clump forming. 21, 91, 144, 159, 165

Elymus racemosus—5′ HT, invasive, rhizomatous.

'Glaucus'—glaucous leaves. 9, 27, 91

Eragrostis curvula—4′ HT, gray-green plumes, green narrow glabrous leaves, good for erosion control. 144

Eragrostis trichodes 'Bend'—4′ HT, purplish plumes in early autumn, leaves dense dark green. 91

Erianthus contortus—5′ HT, flowers in summer, arching and spiraling foliage. 91, 159

Erianthus ravennae—5′ HT, white to beige plumes in fall reaching 7 to 10′ HT. 9, 21, 49, 83, 91, 97, 117, 159, 165, 169, 171

Festuca alpestris—4″ HT. 91

Festuca alpina—8″ HT, 144

Festuca amethystina—10″ HT, purple flowers, fine green leaves. 3

'April Green'—10″ HT, deep green leaves. 9, 37, 65, 91, 153, 165

'Bronzeglanz'—8″ HT, bronzed leaves. 91, 144, 165

'Klose'—10″ HT, leaves olive-green shaded blue. 37, 91

'Superba'—8″ HT, bright blue leaves. 37, 91, 144, 165

Festuca cineraria—8″ HT, fine leaves. 37

'Azurit'—27, 91

'Blaufink' ('Blue Finch')—6′ HT. 91

'Blaufuchs' ('Blue Fox')—1′ HT. 37, 65, 83, 91, 153

'Blauglut' ('Blue Glow')—6″ HT, leaves bright blue. 91

'Blausilber' (Blue Silver')—6″ HT, silver-blue leaves. 144

'Daeumling'—4″ HT, leaves silver. 9, 91

'Fruehlingblau' ('Spring Blue')—6″ HT, leaves silver-blue. 9, 91

'Harz'—6″ HT, leaves olive-green. 91, 165

'Meerblau'—6″ HT, blue-green leaves. 91

'Palatinat'—6″ HT. 3, 91

'Sea Urchin'—6″ HT, blue-green leaves in tight mounds. 9, 37, 65, 165, 171

'Silver Egret' ('Silberreiher')—6″ HT, leaves silver-blue. 37, 91

'Soehrenwald'—8″ HT, olive green-leaves. 91

'Solling'—8″ HT, blue leaves. 91, 165

Festuca elegans—1′ HT, leaves green, upright with curly ends. 91, 144

Festuca gigantea—2′ HT. 91

Festuca glacilis—145

Festuca 'Limerock 15'—15″ HT, pure blue leaves. 165

Festuca mairei—2′ HT. 91, 165

Festuca muelleri—8″ HT. 91

Festuca ovina glauca—8″ HT, fine silvery-blue leaves, evergreen. 9, 21, 49, 63, 67, 83, 97, 98, 109, 133, 139, 153, 159, 165, 169

'Elijah's Blue'—8″ HT, leaves truer blue. 121

'Giant Form'—1.5′ HT, leaves blue. 121

'Viridis'—yellow-green leaves, deep reddish-bronze seedheads. 165

Festuca pallens—4″ HT. 91

Festuca pulchella—3

Festuca pseudeskia—6″ HT. 91

Festuca rupicaprina—4″ HT. 91

Festuca scoparia—4″ HT. 91

'Pic Carlit'—91

Festuca tenuifolia—6″ HT, leaves green and finer than *Festuca ovina*. 83, 91

Festuca vallesiaca 'Glaucescens'—4″ HT 91, 165

Festuca varia—91

Festuca vivipara—91

Glyceria maxima—3′ HT, greenish-cream flowers in summer, arching green leaves, rhizomatous, invasive, requires moist to wet soil. 83

'Variegata'—3′ HT, greenish-cream flowers, green arching leaves striped with creamy yellow. 65, 83, 91, 139, 153, 159, 165, 169

Hakonechloa macro (Phragmites macra)—1.5′ HT, green flowers in summer, short arching leaves, requires some shade. 91

'Alboaurea-variegata'—1′ HT, leaves variegated cream, chartreuse and green. 9, 145

'Aureola'—1′ HT, leaves brilliant yellow striped. 91

Heirochloe odorata—1.5′ HT, arching leaves with a deep green line, fragrant when crushed, requires full sun. 159

***Helictotrichon sempervirens (Avena* spp.)—2′ HT, blue-gray narrow erect leaves, 4′ HT gray flowers, requires excellent drainage. 9, 21, 27, 34, 37, 65, 91, 111, 133, 139, 144, 153, 159, 161, 165, 168, 171

Holcus lanatus 'Variegatus'—8″ HT, leaves soft, pointed, green striped with white, stoloniferous, tolerates dry soils and light shade. 83, 91

Hordeum jubatum—2′ HT, attractive drooping seed heads, tender. 69

Hystrix patula—3′ HT, narrow upright leaves, unusual flower spikes, will grow in sun or partial shade, requires moist soils. 91, 159, 161, 165

Imperata cylindrica—2′ HT, red green grassy leaves, requires moist, well-drained soil and full sun.

'Red Baron' ('Koenigii')—crimson-red leaves. 37, 54, 77, 91, 145, 159, 165

'Rubra'—glowing blood-red leaves. 9, 49, 133, 144, 171

Juncus *effusus*—2′ HT, dark green spiky stems, requires moist to wet soils. 91

'Spiralis'—1′ HT, dark green corkscrew stems. 91

Koeleria *cristata*—2′ HT, silvery-green plumes in summer. 91, 165

Koeleria glauca—2′ HT, bluish flat leaves. 3, 9, 49, 65, 83, 91, 159, 161

Koeleria reuteri (brevifolia)—10″ HT, whitish green or purplish plumes, narrow leaves. 91

Luzula *nivea*—2′ HT, white plumes in spring, tufted leaves, stoloniferous. 9, 49, 91, 143, 159, 161, 165

Luzula pilosa—8″ HT, hairy tufts of leaves. 9, 21, 91, 143, 159, 165

Luzula sylvatica—1′ HT, brown plumes in spring, bright green leaves, stoloniferous. 9, 21, 49, 65, 91, 159, 165

'Hohe Tatra'—91

'Marginata'—leaves edged with gold. 91

Milium *effusum*—2′ HT, thin leaves, prefers partial shade. 91

'Aureum'—bright yellow stems and flowers in spring, requires partail shade. 61, 91, 133

Miscanthus *floridulus*—7 HT', silvery plumes in late summer to 12′ HT, broad arching leaves, will grow in full sun or partial shade and average to moist soil. 21, 91, 144, 159

Miscanthus sacchariflorus—7′ HT, silvery-mauve brown plumes in late summer to 9′ HT, long broad arching leaves. 21, 65, 83, 91, 121, 153

Miscanthus sinensis—6′ HT, brownish flowers in fall to 10′ HT, broad arching leaves, will grow in sun or partial shade and moist to average soils. 9, 21, 41, 49, 83, 91, 159, 165

'Autumn Light'—91, 165

condensatus—purple plumes to 8′ HT, gray arching leaves with a white midrib. 9, 21, 91, 159, 165

'Gracillimus'—5′ HT, buff-purple tinted flowers in fall, thin dark green arching leaves. 9, 21, 29, 34, 39, 41, 49, 65, 67, 77, 83, 97, 109, 133, 153, 159, 165, 169, 171

'Gracillimus Variegatus'—same as 'Gracillimus' but white striping on leaves. 49

'Herbstfeuer'—91

'Morning Light'—4′ HT, variegated leaves. 9, 91, 165

'November Sunset'—9, 91, 165

'Purpurascens'—4′ HT, red tinted plumes in fall turning purple in midsummer, tender. 9, 21, 49, 65, 83, 91, 159, 165, 171

'Silverfeather'—silvery-white plumes in fall. 9, 21, 37, 49, 77, 83, 91, 159, 165

'Strictus'—9, 21, 37, 83, 91, 159, 165

'Variegatus'—leaves striped with white. 9, 21, 37, 65, 67, 77, 83, 91, 97, 117, 144, 153, 159, 165, 171

'Yakujima'—91

'Zebrinus'—silky pink-brown plumes in fall, leaves green marked with yellow bands across leaf blades. 9, 21, 37, 41, 49, 65, 77, 83, 91, 97, 144, 153, 159, 165, 169, 171

Miscanthus transmorrisonensis—3′ HT, shorter version of *M. sinensis* 'Gracillimus', evergreen. 49, 91

Molinia *caerulea*—2.5′ HT, purplish plumes in fall, thin pointed leaves, requires moist soil. 91, 165

arundinacea—6′ HT. 9, 21, 91

'Bergfreund'—9, 91, 165

'Heidebraut'—91, 165

'Karl Foerster'—9, 91, 165

'Moorhexe'—91, 165

'Skyracer'—9, 91, 165

'Staefa'—9, 91, 165

'Strahlenquelle'—91, 165

'Transparent'—91, 165

'Variegata'—leaves striped with cream. 3, 9, 83, 91, 97, 159, 165, 169, 171

***Panicum** virgatum*—5′ HT, brownish feathery panicles in summer, narrow upright leaves, yellow fall color, rhizomatous, requires moist to well drained soil. 9, 21, 49, 65, 83, 91, 113, 117, 127, 144, 153, 159, 161, 165

'Haense Herms'—4′ HT, reddish leaves. 9, 21, 91, 159, 165

'Pee Dee Winter Sunset'—4′ HT, golden plumes changing to tan in winter, light green leaves. 41

'Rehbraun'—4′ HT, red fall color. 21, 91, 165

'Rostrahlbusch'—4′ HT, deep red fall color. 77, 83, 91, 165

'Strictum'—6′ HT, upright blue-green leaf blades. 21, 91, 165

***Pennisetum** alopecuroides*—4′ HT, feathery white plumes with a pink flush in fall, gray-green narrow leaves. 9, 21, 37, 39, 49, 65, 83, 91, 117, 133, 144, 153, 159, 165, 169, 171

'Hameln'—2.5′ HT, compact form. 9, 21, 37, 49, 61, 65, 83, 91, 153, 165

'Hameln Compressum'—2.5′ HT, narrow leaves. 159

'Purpurascens'—dark purple plumes. 9

'Viridescens'—dark purple plumes, greener and wider leaves. 9, 49, 65, 165

'Weserbergland'—2′ HT, dwarf form. 9, 77, 83, 91, 165

Pennisetum caudatum—4.5′ HT, white plumes. 91, 165

Pennisetum incompactum (flaccidum)—3′ HT. 21, 91, 161, 165

Pennisetum setaceum—1′ HT, soft mauve-gray plumes with amethyst tinting from July to October, narrow blue-green leaves, tender. 9, 91, 165

'Rubrum'—4′ HT, plumes and leaves maroon. 91

Pennisetum villosum—1.5′ HT, white plumes in fall, thin leaves, tender. 83

***Phalaris** arundinacea*—4′ HT, blue-green leaves, rhizomatous, requires moist soils.

'Lutea Picta'—leaves edged with yellow. 27, 91

'Picta' ('Variegata')—leaves striped with cream. 9, 21, 37, 49, 63, 65, 67, 83, 91, 97, 139, 143, 144, 153, 159, 165, 169, 171

***Phragmites** australis*—15′ HT, purplish plumes in summer, rhizomatous, grows naturally in salt marshes. 91

***Poa** alpina*—3

'Viviparia'—8″ HT. 91

Poa caesia—6″ HT. 91

Poa chaixii—2′ HT. 91

Poa glauca—8″ HT, blue-green leaves. 91

***Pseudosasa** japonica (Arundinaria japonica)*—15″ HT, dark green narrow pointed leaves, fairly rapid spreader, requires moist humus-rich soil, tender. 83

***Schizachyrium** scoparium (Andropogon scoparius)*—3′ HT, green glaucous leaves, good red fall color, showy seed heads, prefers full sun. 49, 91, 127, 159, 165

***Scirpus** lacustris*—3′ HT, stiff dark green needlelike leaves, tender. 83, 91

***Sesleria** autumnalis*—1′ HT, chartreuse plumes. 27, 91

Sesleria caerulea—1′ HT, blue-green leaves, plumes 2′ HT. 9, 65, 91

Sesleria heufeliana—2′ HT. 91

Sesleria nitida—2′ HT. 91

Shibataea *kumasaca*—6′ HT, broad oval lance-shaped pointed dark green leaves on zigzag stems, rhizomatous. 91

Sorghastrum *avenaceum (nutans)*—6′ HT, yellowish flower heads in summer, good fluffy seed heads, rhizomatous. 91, 107, 113, 127, 159, 165

Spartina *pectinata (michauxiana)*—9′ HT, purple plumes in late summer, coarse arching leaves, rhizomatous, invasive, requires moist to wet soils. 9, 65, 91, 127, 153, 165

'Aureo-marginata'—yellow leaf margins. 21, 83, 91

Spodiopogon *sibiricus*—4′ HT, silver spikes in midsummer, dark green leaves turning red in fall. 21, 91, 159

Sporobolus *heterolepsis*—3′ HT, deep emerald green lacy leaves. 49, 91, 107, 127

Stenotaphrum *secundatum* 'Variegatum'—1′ HT, coarse variegated leaves, stoloniferous, requires moist soil, tender. 91

Stipa *capillata*—4′ HT, white wispy curled flower heads in late summer, stiff upright glaucous thin leaves. 91, 144, 165

Stipa extremorientale—9, 91, 161, 165

Stipa gigantea—6′ HT, glistening purple plumes turning straw-yellow, narrow arching leaves, requires well drained soil, drought tolerant. 83

Stipa pennata—3′ HT, white wispy flower heads in summer, thin leaves. 91, 159, 165

Stipa rubens—1′ HT. 91

Thamnocalamus *spathaceus*—15′ HT, narrow drooping leaves, clump forming. 91

Themeda *triandra japonica*—5′ HT, upright narrow habit. 91, 161

Aquatic Plants

Aquatic Plant collection—11, 41, 54, 66, 91

Acorus *calamus*—3′ HT, greenish-yellow flowers in spring and summer, grown for its swordlike foliage. 54, 66, 91, 98, 139

'Variegatus'—leaves striped with cream. 91

Acorus gramineus—1′ HT, insignificant flowers, swordlike foliage. 91

'Eco Mt. Emei'—9″ HT, leaves green. 54

'Ogon'—10″ HT, golden stripes on foliage. 27, 91

'Pusillus'—4″ HT, shorter form of species. 54, 91

'Pusillus Variegatus'—4″ HT, white variegated foliage. 145

'Variegatus'—8″ HT, green and white striped foliage. 9, 37, 49, 54, 61, 91

Aletris *aurea*—2′ HT, yellow flowers in summer, green grasslike leaves. 173

Aletris farinosa—2.5′ HT, white flowers in summer, green grasslike leaves. 66, 173

Butomus *umbellatus*—3′ HT, rose-pink flowers in summer, grasslike leaves. 83

Caltha *palustris*—1′ HT, yellow flowers in spring, rounded waxy leaves dying back in midsummer. 9, 25, 37, 65, 66, 83, 120, 133, 137, 139, 153

'Alba'—white flowers. 3, 9, 29, 83

'Flore Plena' ('Montrosa' and 'Multiplex')—double yellow flowers. 9, 29, 83, 145

Drosera *rotundifolia*—10″ HT, white clusters of flowers, leaves spoonlike rosettes covered with red hairs that exude sticky dew, insectivorous bog plant. 11, 120

Equisetum *hyemale*—4′ HT, green hollow stems, evergreen. 91, 144

robustum—6′ HT. 91

Equisetum scirpoides—8″ HT, vigorous. 91

***Iris** hexagona*—4′ HT, lilac flowers in summer, long sword-shaped leaves. 45, 54, 181

Iris x *nelsonii*—3′ HT, bright red-purple in summer, sword-shaped leaves. 45

Iris pseudacorus—4′ HT, bright yellow flowers with violet veins in early summer, requires full sun. 21, 25, 29, 41, 45, 54, 61, 65, 66, 83, 91, 117, 121, 133, 137, 159, 173

'Alba'—creamy white flowers. 159

'Flore Plena'—3′ HT, irregular double flowers. 9, 165, 171, 173

'Variegata'—yellow and green leaves. 29, 83

Iris versicolor—2.5′ HT, purplish-blue flowers with white and yellow markings in early summer, narrow gray-green leaves, requires full sun, will not grow in deep water. 29, 45, 61, 66, 83, 117, 120, 139, 159, 165, 173

'Claret Cup'—red-violet flowers with white and yellow markings. 29, 173

'Kermisiana'—rich claret and white flowers. 29

'Red Hybrid'—red and white flowers. 29

'Rosea'—soft rose and white flowers. 29

Iris virginica—3′ HT, lavender, lilac or violet flowers with white markings in summer, bright green arching sword-shaped leaves, will not grow in deep water. 41, 45, 54, 173

'Alba'—white flowers. 29

'Contraband Girl'—more vigorous, paler flowers. 173

shrevei—larger flowers. 25, 127

***Kosteletzkya** virginica*—5′ HT, pink mallowlike flowers in fall, lobed triangular leaves, requires full sun. 113, 115, 157, 181

***Menyanthes** trifoliata*—1″ HT, white flowers, oval trifoliate leaves, prostrate habit, found naturally in bogs. 120

***Nuphar** luteum*—6″ HT above water, bright yellow flowers in summer, oval leathery floating leaves. 83

Nymphaea 'Attraction'—large red flowers. 83

Nymphaea 'Gladstone'—large pure white flowers open all day, rounded red leaves turning green. 83

Nymphaea x 'Moorei'—large creamy yellow flowers, rounded pale green leaves spotted purple. 83

***Nymphoides** peltata*—roots grow in mud or sand, leaves float on water, bright yellow umbels of flowers in summer, spreads rapidly by runners. 83

***Peltandra** sagittaefolia*—3′ HT, white flowers in early summer, green arrow-shaped leaves, prefers boggy soils. 181

***Pontederia** cordata*—2′ HT, violet-blue spikes in late summer, glossy heart-shaped leaves, vigorous spreader. 83

***Sagittaria** sagittifolia*—2′ HT, small white spikes in summer, pale green arrow-shaped leaves, somewhat invasive, tubers used for food in the Orient. 83

***Sarracenia** flava*—2′ HT, greenish yellow spikes in early spring, upright tubular red-veined leaves with a lid for trapping insects, rhizomatous, prefers partial shade. 66

Sarracenia leucophylla—4′ HT, white flower spikes in summer, tubular white-veined purple leaves with a lid for trapping insects, prefers partial shade. 83

Sarracenia purpurea—1.5′ HT, small red flower spike in early summer, evergreen tubular red-veined leaves with a lid for trapping insects. 66, 83, 120, 173

***Typha** angustifolia*—5′ HT, brown cylinders in summer, narrow bright green leaves, invasive. 165

Typha latifolia—10′ HT, brown cylinders in summer, narrow gray-green leaves, invasive. 66, 83, 120

Typha minima—2.5′ HT, brown cylinders in summer, invasive.

Achillea ageratum: SWEET YARROW—1.5′ HT, yellow flowers in summer, green toothed leaves. 69

Achillea moschata—6″ HT, yellow/white flowers in summer, bright green leaves. 159

Agastache foeniculum: ANISE HYSSOP—4′ HT, pink flowers in summer, green fragrant leaves. 37, 49, 69, 98, 183

Agastache mexicana: MEXICAN GIANT HYSSOP—4′ HT, rose pink flowers in summer, tender green fragrant leaves. 175

Agastache rugosa: WRINKLED GIANT HYSSOP—4′ HT, pink flowers in summer and fall, green crinkled leaves. 183

Agastache urticifolia: NETTLE-LEAF GIANT HYSSOP—similar to *A. foeniculum*. 61

Agrimonia eupatoria: AGRIMONY—4′ HT, yellow flowers in summer, hairy leaves. 69

Allium schoenoprasum: CHIVES—1.5′ HT, lilac-purple flowers in summer, grasslike green persistent foliage. 5, 9, 33, 37, 49, 69, 159, 169, 183

'Forescate'—1.5′ HT, rose-pink flowers. 37, 159

'Schnittlauch'—8″ HT, dwarf form of species. 169

Allium tricoccum: WILD LEEK—1′ HT, greenish white flowers in spring. 66, 120

Allium tuberosum: GARLIC CHIVES—1.5′ HT, white flowers in summer and fall. 25, 37, 49, 69, 109, 117, 183

Aloysia triphylla: LEMON VERBENA—4′ HT, white flowers, fragrant foliage, tender. 9, 37, 69, 98, 183

Althaea officinalis: MARSH MALLOW—4′ HT, pale rose flowers in summer, gray-green foliage. 69

Anchusa officinalis:BUGLOSS—1.5′ HT, blue flowers in spring, coarse hairy foliage. 69

Angelica archangelica: ANGELICA—5′ HT, flat white flowers in summer, divided fresh green leaves. 37, 69, 98

Angelica triquinata (curtisii)—1′ HT, white flowers in summer, finely cut leaves. 66

Apios americana: GROUNDNUT—8′ HT, brownish flowers in summer, edible fruiting vine, pealike leaves. 61

Artemisia abrotanum: SOUTHERNWOOD—3′ HT, green ferny aromatic foliage. 9, 37, 49, 69, 77, 95, 98, 183

'Citriodorum' ('Tangerine')—citrus-scented foliage. 69, 183

Artemisia camphorata—2.5′ HT, yellow flowers, green camphor-scented foliage. 49, 69, 183

Artemisia campestris—3′ HT, gray-green dissected leaves. 183

Artemisia dracuncunculus: TARRAGON—2.5′ HT, foliage fine green licorice flavor. 9, 49, 95, 98, 159, 165, 169, 183

'Sativa'—2′ HT, French Strain, better flavor. 37, 69, 183

Artemisia pontica: ROMAN WORMWOOD—4′ HT, flowers whitish-yellow, gray pubescent leaves. 37, 98, 144, 159

Baptisia tinctoria: WILD INDIGO—2′ HT, yellow flowers in summer, fine textured leaves, used for dye. 66, 173.

Calamintha grandiflora: CALAMINT—2′ HT, pink flowers in summer, leaves mintlike fragrance. 69, 98, 161

Calamintha nepeta: CALAMINT—1′ HT, white or lilac flowers in late summer, leaves smaller than *C. grandiflora*, but with same mint fragrance. 69

nepeta (nepetoides)—1′ HT, pale lavender flowers. 34

Campanula rapunculus: RAMPION—3′ HT, small lilac flowers, green rosettes of leaves. 161

Chamaemelum nobile: CHAMOMILE—8″

HT, white daisy flowers, leaves finely cut, bright green, fragrant when crushed. 37, 69, 98, 183

'Plenum'—3″ HT, double white flowers. 95

'Treneague'—2″ HT, nonflowering form, strongly scented. 37, 69

Chenopodium *bonus-henricus*: GOOD KING HENRY—2′ HT, arrow-shaped leaves. 69, 183

Chrysanthemum *balsamita*: COSTMARY—3′ HT, golden-yellow buttonlike flowers in summer, long gray-green coarse leaves. 37, 49, 69, 98, 159, 183

Chrysanthemum cinerariifolium: PYRETHRUM—1′ HT, small white daisies in summer, leaves lobed, silvery beneath. 69

Cichorium *intybus*: CHICORY—4′ HT, azure-blue flowers in summer, green rosettes of leaves at base only. 52, 123, 183

Coptis *trifolia*: GOLDTHREAD—6″ HT, white and yellow flowers in spring, shiny leaves divided in threes. 139

Foeniculum *vulgare*: FENNEL—4′ HT, yellowish-green flat-topped clusters of flowers in summer, leaves finely divided, hairy, licorice flavored. 37, 49, 69, 83

dulce—large fruit. 183

'Purpureum' ('Bronze')—leaves deep purplish-mahogony, changing to bronze in midsummer. 69

Galega *officinalis*: GOAT'S RUE—5′ HT, purple, lilac and pink flowers in summer, pealike leaves. 49, 61, 65, 69, 153, 159, 161

Galium *mollugo*: WHITE BEDSTRAW—3′ HT, white fragrant starlike flowers in late spring, green whorled leaves, sprawling stems. 69

Galium odoratum: SWEET WOODRUFF—10″ HT, white starlike fragrant flowers in spring, green whorled fragrant leaves. 3, 9, 21, 29, 37, 49, 65, 67, 69, 91. 95, 97, 98, 133, 137, 143, 153, 159, 169, 177, 183

Galium verum: YELLOW BEDSTRAW—2′ HT, fragrant yellow flowers in late spring, whorled gray-green leaves. 37, 52, 69, 133, 183

Hydrastis *canadensis*: TURMERIC—1′ HT, small white flowers, large lobed leaves, crimson berries, requires shade and moist rich soil. 11, 66, 137

Hyssopus *officinalis*: HYSSOP—2′ HT, blue, pink and white flowers in summer, small fragrant evergreen leaves, requires good drainage. 37, 49, 69, 159, 175, 183

'Alba'—white flowers. 69

'Rosea'—pink flowers. 69

'Sissinghurst'—1.5′ HT, compact form with pink flowers and erect habit. 37

Inula *helenium*: ELECAMPANE—6′ HT, deep yellow flowers with thin petals in late summer, coarse hairy leaves, requires moist to wet soils. 37, 69, 165, 183

Isatis *tinctoria*: DYER'S WOAD—4′ HT, small bright yellow flowers in summer, narrow leaves. 69, 183

Lavandula *angustifolia (officinalis* and *vera)*: ENGLISH LAVENDER—2′ HT, purplish-blue fragrant flowers in early summer, fragrant small gray semievergreen leaves, requires full sun and well-drained soil. 9, 49, 61, 69, 97, 98, 107, 121, 122, 159, 169, 183

'Dwarf Blue'—1′ HT, dark blue flowers. 37, 65, 153

'Grey Lady'—1.5′ HT, lavender-blue flowers, silvery gray leaves. 37, 65, 95, 153

'Grosso'—2′ HT, deep violet flowers. 34

'Hidcote'—15″ HT, deep purple flowers, silvery gray leaves. 3, 9, 29, 34, 37, 65, 77, 83, 91, 95, 98, 133, 153, 159, 161, 169, 171, 175, 177, 183

'Jean Davis'—1.5′ HT, pink flowers, blue-green leaves. 9, 29, 37, 65, 153, 159, 169, 171

'Munstead'—2′ HT, lavender-blue flowers in early spring, gray leaves. 9, 21, 27, 33, 37, 65, 83, 107, 137, 144, 153, 157, 159, 161, 169, 171, 175, 183

'Munstead Dwarf'—1′ HT, deep purple-blue flowers. 77, 177

'Nana'—1′ HT, compact form. 95, 145

'Nana Baby White'—compact form with white flowers. 145

'Twickel Purple'—1.5′ HT, fanlike cluster of light purple flowers. 37

Lavandula dentata: FRENCH LAVENDER—2′ HT, purple flowers, toothed gray woolly leaves, requires full sun and well-drained soil, tender. 37, 69, 98, 183

candicans—larger leaves. 159

Lavandula lanata—2′ HT, bright purple flowers, woolly gray leaves, requires full sun and well-drained soil. 69, 98, 159

Lavandula latifolia (spica)—3′ HT, purplish flowers, gray-green woolly leaves, requires full sun and well drained soil. 69, 98, 159

Lavandula stoechas: SPANISH LAVENDER—1.5′ HT, purple flowers with deep purple bracts, woolly lance-shaped leaves, requires full sun and well-drained soil, tender. 69, 98

Leonurus cardiaca: MOTHERWORT—5′ HT, pale purple flowers in summer, lobed coarse leaves. 69, 123, 183

Levisticum officinale: LOVAGE—6′ HT, greenish yellow flat flower clusters in summer, divided coarsely toothed leaves that taste like celery, requires moist soil and full sun. 37, 49, 69, 183

Lycopus europaeus: WATER HOREHOUND—3′ HT, white flowers dotted with purple in summer, coarse lobed leaves, invasive, requires damp to wet soil. 69

Marrubium incanum: WOOLLY HOREHOUND—2.5′ HT, small white flower spikes in late summer, gray woolly rounded leaves, requires sandy soil and full sun. 37

Marrubium vulgare: COMMON HOREHOUND—2′ HT, small white flower spikes in summer, downy leaves, requires full sun. 37, 69, 98, 107, 159

Melissa officinalis: LEMON BALM—2.5′ HT, oval hairy lemon-scented leaves, rhizomatous, invasive. 9, 33, 37, 49, 65, 69, 95, 98, 107, 144, 153, 159, 175, 183

'Aurea'—leaves spotted with yellow. 65, 153, 183

'Variegatus'—leaves variegated with cream. 65, 153, 183

Mentha: all are invasive spreading by rhizomes, require moist soil and full sun or partial shade, flowers are insignificant.

Mentha arvensis: FIELD MINT—2′ HT, white or pink flowers in summer, lance-shaped hairy leaves. 120

villosa (canadensis)—densely pubescent stems. 3

Mentha aquatica: WATER MINT—3′ HT, lemon-scented lance-shaped leaves. 37, 183

crispa—hairy and curly leaves. 49, 98, 153, 159

Mentha x *gentilis*: RED MINT—1.5′ HT, spearmint-scented red leaves. 69

Mentha longifolia 'Capensis': HORSEMINT—2′ HT, spearmint-scented long narrow pointed leaves. 183

Mentha x *piperita*: PEPPERMINT—2′ HT, purple flowers in fall, lance-shaped leaves. 33, 37, 49, 65, 69, 83, 95, 98, 107, 153, 159, 183

'Blue Balsam'—shiny purple-tinted leaves. 9, 183

'Chocolate': CHOCOLATE MINT—dark green chocolate-flavored leaves. 37, 98, 183

citrata: ORANGE MINT—citrus-flavored leaves. 9, 37, 49, 65, 69, 98, 159, 183

'Crispum'—curled edges on leaves. 37

'Variegatum'—variegated leaves. 98

vulgaris—dark red stems and dark green leaves. 9

Mentha pulegium: PENNYROYAL—10″ HT, blue flowers, narrow dark green leaves, tender. 37, 69, 98, 159, 183

Mentha requienii: CORSICAN MINT—3″ HT, purple flowers in summer, peppermint-scented leaves, prostrate. 37, 69, 95, 98, 133, 144, 181, 183

Mentha spicata (viridis): SPEARMINT—2.5′ HT, smooth dark green lance-shaped leaves. 9, 33, 49, 65, 69, 95, 98, 107, 153, 159, 183

'Crispata' ('Crispum')—curled leaves. 9, 69, 183

'Emerald and Gold'—green leaves streaked with gold, ginger spearmint flavor. 65, 153, 159, 183

'Kentucky Colonel' (*cordifolia*)—large bright green leaves. 37, 98, 183

'Variegata'—cream variegated leaves. 37

Mentha suaveolens (rotundifolia, villosa and *alopecuroides)*: APPLE MINT—2′ HT, coarse tomentose apple-flavored leaves. 9, 37, 69, 98, 153, 183

'Variegata': PINEAPPLE MINT—2′ HT, leaves splashed with white. 9, 49, 69, 95, 144, 53, 171

Myrrhis *odorata*: MYRRH—3′ HT, creamy white flat-topped clusters of flowers in early summer, dark green finely dissected anise-scented leaves, requires moist soil and will grow in full sun or partial shade. 37, 49, 98

Nepeta *cataria*: CATNIP—2.5′ HT, white flowers spotted with pale purple in summer, downy gray-green aromatic leaves, requires well-drained soil. 37, 49, 52, 69, 98, 107, 120, 123, 183

'Citriodora'—lemon-scented leaves. 69, 183

Origanum *dictamnus*: DITTANY OF CRETE—1′ HT, purple spikes in late summer, small oval woolly leaves, requires good drainage, full sun and sandy soil. 37, 69, 98, 183

Origanum heracleoticum (hirtum): POT MARJORAM—very similar to *O. vulgare*. 37, 69, 98, 144, 183

Origanum pulchellum—1.5′ HT, pink flower spikes in summer, small gray aromatic leaves. 9, 34, 37, 95, 98, 145, 183

Origanum virens—similar to *O. vulgare*, but larger flowers. 69

Origanum vulgare—1.5′ HT, lilac flowers in late summer, aromatic small lance-shaped leaves, prostrate habit, prefers full sun and sandy well-drained soil. 37, 49, 65, 69, 95, 98, 107, 153, 159, 171

'Aureum'—yellow leaves turning green in midsummer. 9, 37, 49, 65, 69, 98, 133, 153, 159, 183

'Compactum Nana'—4″ HT, short purple spikes in summer, dark green mats turning purple in winter. 144, 145

'Nanum'—10″ HT, compact form. 37

'Olympicum'—1.5′ HT, white flowers. 183

Panax *quinquefolius*: GINSENG—1.5′ HT, greenish-white flowers in early summer, leaves in threes or fives, toothed, red fruits. 66, 137, 139, 171, 173

Parthenium *integrifolium*—4′ HT, small yellow and white flowers in spring and summer, requires well drained soil. 127

Petroselinum *crispum*: PARSLEY—12″ HT, white flat flower clusters in summer, edible bright green compound leaves, biennial. 37

neapolitanum: ITALIAN PARSLEY—1.5′ HT, more flavorful than species, flat broad leaves. 37

Poterium *sanguisorba*: BURNET—2′ HT, greenish flowers in early summer, edible compound leaves. 9, 37, 49, 69, 83, 98, 183

Psoralea esculenta—1.5′ HT, yellow or blue flower spikes, smooth oblong compound leaves, requires well-drained soil. 127

Pycnanthemum muticum: MOUNTAIN MINT—3′ HT, pink flowers clusters in summer, oval lance-shaped finely toothed leaves. 65, 153, 159

Rosmarinus officinalis (angustifolia): ROSEMARY—2.5′ HT, pale blue flowers in summer, short needlelike leaves, requires well-drained soil and full sun, tender. 9, 37, 49, 65, 95, 98, 107, 153, 159, 183

'Albus'—white flowers. 37, 69, 98

'Arp'—lemon fragrance, gray-green leaves, supposedly hardier than species. 9, 34, 37, 98

'Beneden Blue'—bright violet-blue flowers, more compact than 'Prostratus'. 37

'Blue Boy'—blue flowers, leaves small on prostrate growth. 37, 98

'Collingwood Ingram'—dark violet-blue flowers, deep green leaves. 34, 69, 98

'Golden Rain'—blue flowers, leaves streaked with gold. 98, 183

'Huntington Carpet'—sky-blue flowers, compact. 37, 98

'Lockwood de Forest' (foresteri)—bright violet-blue flowers, small leaves on stems with a spiralling habit. 37, 98

'Majorica'—pale pink flowers. 69, 183

'Pinkie'—bright pink flowers, thin leaves on erect stems. 98

'Prostratus'—bright blue flowers, prostrate habit. 9, 37, 49, 65, 69, 153, 159, 171, 183

'Tuscan Blue'—violet-blue flowers, upright habit. 37

Rubia tinctorum: MADDER—1′ HT, greenish yellow flowers in summer, whorled lance-shaped leaves. 69

Rumex acetosa: SORREL—3′ HT, oblong coarse edible leaves, requires rich moist soil. 37, 49, 69, 183

Rumex scutatus: FRENCH SORREL—8″ HT, small lobed leaves on trailing stems. 69, 159

Ruta graveolens: RUE—2′ HT, yellow flowers in summer, small gray-green aromatic leaves, requires good drainage. 9, 49, 83, 98, 159, 175, 183

'Blue Beauty'—2′ HT, compact habit. 37, 65, 153, 171

'Blue Curl'—2′ HT, compact habit. 98

'Blue Mound'—1.5′ HT, dwarf compact habit. 95, 133

'Curly Girl'—1′ HT, lacy leaves, compact habit. 145

Salvia elegans (rutilans): PINEAPPLE SAGE—3′ HT, scarlet flowers in summer and fall, aromatic pineapple-scented foliage, tender. 9, 37, 69, 98, 153, 159, 183

Salvia officinalis: SAGE—3′ HT, white flowers in summer, gray-green oblong crinkled leaves. 33, 37, 49, 63, 65, 69, 75, 91, 95, 98, 107, 153, 159, 183

'Compacta'—15″ HT, compact form of species. 9, 37, 65, 153, 159

'Icertina' ('Aurea' and Gold Variegated')—2′ HT, leaves irregularly marked with golden-yellow. 37, 65, 95, 98, 153, 159, 183

'Purpurescens'—purple leaves. 9, 37, 65, 69, 95, 153, 159, 183

'Tricolor'—green leaves marked with pink and white, tender. 9, 37, 65, 69, 91, 95, 98, 153, 159, 171, 183

Salvia sclarea: CLARY SAGE—4′ HT, blue to light pink flowers, large gray-green crinkled strongly aromatic leaves. 37, 69

Salvia verbenaca—2′ HT, bright blue flowers, oblong lobed leaves, tender. 69

Santolina chamaecyparissus (incana)—2′ HT, yellow buttonlike flowers in summer,

aromatic leaves finely divided into thin segments, evergreen, requires excellent drainage, tender. 9, 37, 49, 69, 91, 98, 159, 165, 169, 175

'Nana'—8″ HT, dwarf form. 9, 37, 159, 165, 177

'Pretty Carroll'—1′ HT, compact form, soft gray evergreen leaves. 37, 91, 144, 159, 175

Satureja montana: WINTER SAVORY—1′ HT, pink or white flowers in summer, lance-shaped aromatic leaves. 9, 37, 49, 65, 69, 95, 98, 133, 153, 159, 183

repanda—4″ HT, white flowers, tiny green leaves. 37, 65

Stachys officinalis: BETONY—2′ HT, purple whorled flowers in summer, heart-shaped toothed leaves with a mint flavor. 69

Symphytum officinale: BONESET—3′ HT, yellowish white flowers in summer, oblong coarse hairy leaves, prefers moist soil and light shade. 37, 49, 63, 69, 98, 183

Tanacetum vulgare: TANSY—3′ HT, yellow buttonlike flower clusters in summer, finely cut compound aromatic leaves, rhizomatous. 37, 49, 69, 91, 97, 120, 123, 183

'Crispum'—more crinkled leaves, less vigorous. 9, 25, 37, 65, 69, 91, 98, 153, 183

Thymus camphoratus—1′ HT, rose to purple flowers in summer, camphor-scented leaves, woolly beneath, tender. 98

Thymus carnosus—9″ HT, white flowers in summer, pine-scented leaves, tender. 98

Thymus x *citriodorus*: LEMON THYME—8″ HT, pale lilac flowers in summer, evergreen citrus-scented leaves. 9, 37, 65, 69, 83, 97, 153, 159, 169, 177, 183

'Argenteus'—6″ HT, silver and green leaves. 9, 37, 65, 83, 95, 153

'Aureus'—golden-edged leaves. 37, 49, 65, 69, 77, 95, 98, 133, 144, 153, 159

'Doone Valley'—4″ HT, gold and green leaves, leaves turning red in fall. 37, 137, 144, 183

'E. B. Andersen'—4″ HT, new leaves bright gold with maroon undersides. 34, 37

'Gold Edge'—leaves edged with gold. 65, 77, 144, 153, 177

'Silver Queen'—leaves variegated with cream and gray. 77, 133, 145, 177

'Variegata'—leaves variegated with cream. 9, 133

Thymus herba-barona: CARAWAY THYME—5″ HT, rose-pink flowers in summer, deep green evergreen leaves with a caraway scent. 9, 34, 37, 65, 69, 95, 98, 137, 153, 159, 183

Thymus 'Nutmeg'—5″ HT, nutmeg-scented leaves. 37, 183

Thymus 'Oregano'—oregano-scented leaves. 37, 183

Thymus 'Pine Scented'—pine-scented leaves. 183

Thymus 'Porlock'—10″ HT, pink flowers. 37

Thymus praecox arcticus (drucei): MOTHER OF THYME—4″ HT, rose to purple flowers in summer, oval scented leaves. 9, 69

'Albus'—white flowers. 21, 34, 69, 144, 183

'Coconut'—sweet scented leaves. 9, 69

'Minus'—2″ HT, purple to red flowers, tiny gray hairy leaves. 34, 95, 137

Thymus serpyllum: WILD THYME—prostrate habit, purple flowers in summer, evergreen to elliptic mosslike leaves. 3, 33, 37, 49, 75, 95, 121, 183

'Album'—white flowers. 9, 37, 65, 91, 95, 133, 137, 145, 153, 159, 177

'Aureus'—new growth on leaves is pure gold changing to green-gold. 3, 83, 98

'Carneus'—pale flesh flowers. 65, 83, 153

'Coccineum'—deep red flowers. 3, 9, 21, 29, 37, 65, 67, 77, 83, 95, 121, 133, 137, 153, 159, 169, 177, 183

'Elfin'—purple flowers, tiny dark green leaves. 145

'Minus'—pink flowers, tiny leaves. 9, 83, 95, 133, 145

'Pink Chintz'—bright pink flowers, small gray leaves. 37, 95, 133, 145, 183

'Rosea'—rose-red flowers, bright green leaves. 9, 65, 83, 153

Thymus vulgaris: COMMON THYME—10″ HT, lilac to purple flowers in late spring, evergreen narrow tomentose leaves on upright stems. 33, 49, 65, 83, 98, 107, 153, 159, 183

'Alba'—white flowers. 37

'Argenteus'—leaves edged with white. 37, 65, 69, 97, 137, 153, 159, 183

'Compactus'—4″ HT, compact habit, gray-green leaves. 9, 65, 153

'Downhill Farm'—leaves larger than species. 183

'Fragrantissima'—1′ HT, leaves narrow, orange scented. 69

'German' ('Winter')—looser habit than species. 37

'Silver Posie'—tiny leaves with white edges, tender. 98

Tussilago farfara: COLTSFOOT—1′ HT, bright yellow dandelion flowers in early spring, large rounded toothed leaves, white tomentose beneath, rhizomatous, can be invasive, prefers moist soils. 69

Valeriana officinalis: COMMON VALERIAN—5′ HT, white, pink and lavender fragrant flowers in midsummer, pinnately compound leaves, requires moist soils. 9, 37, 63, 69, 98

Verbena hastata: BLUE VERVAIN—6′ HT, violet flowers on branched spikes in summer, narrow toothed leaves on stiff upright stems. 69, 117, 123

Bulbs, Corms, Tubers and Rhizomes

Agapanthus africanus—3′ HT, deep blue flowers in summer, broad green grasslike foliage, tender. 177, 181

'Albus'—white flowers. 37, 54, 177, 181

'Albus Nanus'—1.5′ HT, white flowers. 37

'Blue Giant'—deep blue. 37

'Blue Triumphator'—azure blue, hardier. 37

'Headbourne Hybrids'—blue and white flowers, hardier. 37, 49, 177

'Peter Pan'—1.5′ HT, deep blue. 3, 37, 173, 177

Allium aflatunense—3′ HT, violet flowers in early summer. 27, 99, 139, 177

Allium ampeloprasum—4′ HT, rose flowers in summer. 54, 173

Allium caeruleum—2′ HT, blue flowers in spring. 54

Allium cepa (cepaproliferum)—2′ HT, grown for edible bulbs produced at tops of stalks. 69

Allium cernuum—1.5′ HT, rosy-lilac flowers in summer. 25, 37, 61, 77, 117, 127, 139, 159

Allium christophii (albopilosum)—1.5′ HT, 8″ lilac flowers in early summer. 27, 177

Allium cuthbertii—1.5′ HT, silvery-pink flowers in summer. 173

Allium cyaneum—8″ blue-violet flowers in spring. 133, 139

Allium flavum—10″ HT, yellow flowers in spring. 159

Allium giganteum—4.5′ HT, bright lilac flowers in summer. 27, 122, 171, 177

Allium karataviense—6″ HT, mauve flowers in spring, ornamental pewter-green straplike foliage. 139

Allium moly—8″ HT, yellow flowers in spring. 27, 177

Allium neapolitanum—2′ HT, pure white flowers in summer. 161

'Grandiflorum'—larger flower heads. 177

Allium nigrum (multibulbosum)—2.5′ HT, white to pale lilac flowers with yellow anthers. 122

Allium ostrowskianum—1′ HT, rose flowers in spring. 177

Allium oreophilum—4″ HT, purple flowers. 122

Allium pulchellum—1.5′ HT, lilac flowers in summer, bluish foliage. 37, 54, 161

Allium ramosum—1.5′ HT, white flowers with red central nerve in summer. 173

Allium roseum—1′ HT, bright lilac-pink flowers in spring. 27

'Album'—white flowering variety. 54

'Grandiflorum'—larger flower heads than the species

Allium senescens—1.5′ HT, lilac-rose flowers in summer, tufted broad leaves. 9, 37, 77, 173

'Glaucum'—6″ HT, pink flowers in summer, leaves twisted, gray-green in color. 37, 54, 98, 133, 159, 173

Allium sphaerocephalum—1.5′ HT, wine-purple flowers in summer. 54

Allium splendens (virgunculae)—10″ HT, rose, purple or pink flowers in fall. 37, 133, 159, 173.

Allium thunbergii—2′ HT, red-purple flowers in fall. 77, 173

'Ozawas'—10″ HT, red-violet flowers in fall. 37

Amianthium *muscitoxicum (Zigadenus muscitoxicum)*—4′ HT, white flowers on branching spikes in summer, long slender leaves, poisonous. 66

Anemone *blanda*—5″ HT, fernlike foliage, blue, white and pink flowers bloom in spring. 27

'Blue Star'—blue flowers with golden centers. 177

'Pink Star'—pink with golden center. 177

'White Splendour'—white with golden center. 177

Anemone *coronaria*—12″ HT, slightly tender tuber.

'St. Piran Mixed'—171

'St. Brigid Creagh Castle'—double red, pink, blue, mauve, and white flowers in spring. 171

Anemone x *fulgens*—15″ HT, crimson flowers in spring. 177

Anemone nemorosa—6″ HT, mixed flowers in spring, tuber. 9, 173

'Alba Plena'—double white flowers. 139

'Allenii'—10″ HT, lavender-blue flowers. 139

robinsoniana—5″ HT, soft blue flowers. 139

'Royal Blue'—6″ HT, rich blue flowers. 11

'Virescens'—4″ HT, green fringed flowers. 139

'Wilkes'—10″ HT, large white flowers. 139

Anemone ranunculoides—6″ HT, yellow flowers in spring, cleft foliage. 11, 139

Babiana *stricta*—1′ HT, blue, rose and pink fragrant flowers in early summer, tender. 171

Belamcanda *chinensis*—2.5′ HT, orange spotted with red or purple flowers in summer, irislike leaves. 9, 21, 29, 39, 49, 52, 61, 63, 65, 77, 91, 95, 97, 107, 109, 113, 115, 137, 157, 159, 165, 169, 171, 173, 177

'Freckle Face'—2.5′ HT, apricot flowers spotted with red. 37

Belamcanda flabellata

'Alice'—34

'Hello Yellow'—1.5′ HT, clear yellow flowers. 37, 49, 173

'Rob Roy'—34

***Bulbocodium** vernum*—6″ HT, violet-purple flowers in early spring. 171

***Camassia** cusickii*—3′ HT, soft blue flowers in late spring, grasslike leaves dying back in August, requires moist to wet soils. 177

Camassia leichtlinii 'Blue Danube'—3′ HT, lavender-violet flowers in late spring, requires moist soil. 27

Camassia quamash (esculenta)—3′ HT, rich purple flowers in late spring, requires moist soil. 171

***Canna** flaccida*—5′ HT, yellow flowers in summer, leaves 2′ long by 5″ wide, requires full sun, tender. 181

***Chionodoxa** luciliae*—3-6″ HT, bright blue flowers with a white center in early spring.

'Alba'—white form. 177

'Gigantea'—larger flowering form. 27, 171, 177

'Pink Giant'—pink flowers. 122, 171

Chionodoxa sardensis—6″ HT, rich blue flowers with smaller white centers in early spring, more flowers per stem. 122, 171

***Colchicum** autumnale*—leaves appear after blooming and last until early summer, flowers appear in the fall.

'Album'—6″ HT, white flowers. 171

'Majus'—bright pink flowers. 139, 171

Colchicum cilicicum—6″ HT, deep rosy-lilac flowers in fall. 121

Colchicum 'Conquest'—6″ HT, rich red-violet flowers in fall. 54

Colchicum 'Lilac Wonder'—6″ HT, lilac flowers in fall. 27, 139

Colchicum 'Roseum Plenus'—8″ HT, double rose flowers in fall. 139

Colchicum speciosum 'Album'—6″ HT, white flowers in fall. 177

Colchicum 'The Giant'—6″ HT, reddish-pink flowers in fall, largest of the colchicums. 27, 54, 177

Colchicum 'Waterlily'—double amethyst-violet flowers. 27, 122, 139, 171, 177

***Convallaria** majalis*—8″ HT, white fragrant bell-shaped flowers in spring, requires moist soil, invasive. 3, 21, 63, 66, 67, 77, 83, 91, 95, 97, 107, 122, 137, 165, 169, 171, 177

'Flore Pleno'—double flowers, not invasive. 95, 133

'Fortunei'—flowers and leaves larger than species. 9, 159, 171, 177

'Rosea'—mauve-pink flowers. 9, 143, 159

'Variegata'—white single flowers, creamy yellow variegated leaves, requires some sun. 133

Convallaria montana—10″ HT, similar to *C. majalis*, but larger, not invasive, requires some shade. 173

***Crinum** americanum*—2′ HT, white fragrant flowers in summer, straplike leaves, tender. 41, 181

Crinum x *powellii*—2.5′ HT pink or white fragrant flowers in summer. 91

'Album'—white flowers. 171

'Roseum'—rose-pink flowers. 171

***Crocosmia** aurea*—3′ HT, apricot-yellow flowers flushed with orange, tender. 54

Crocosmia x *crocosmiiflora*—2′ HT, orange-red flowers in late summer. 41, 117

'Emily McKenzie'—orange flowers in fall. 37, 49

'James Coey'—2′ HT, red flowers in late summer. 37

'Lucifer'—3.5′ HT, scarlet flowers in summer 37, 49, 65, 91, 139, 159, 169, 171

Crocosmia masoniorum—3′ HT, red flowers in late summer. 37

'Firebird'—3′ HT, orange-red flowers with a green throat. 159, 171

Crocosmia pottsii—3′ HT, vermilion-red flowers with a yellow throat. 65, 153

Crocosmia 'Solfatare'—2′ HT, yellow flowers, bronze tinged grassy leaves, tender. 171

Crocus collection—bloom in early spring. 27, 177

Crocus ancyrensis—golden-yellow flowers in late winter. 27

Crocus biflorus (weldenii)—bloom in early spring.

adamicus—yellow base, alternately white and purple petals with a silvery interior. 171

albus—4″ pure white with yellow stamens

'Fairy'—petals alternate lavender and white. 171

Crocus chrysanthus—4″ HT, blooms in spring.

'Advance'—bronze-veined leaves, purple outside and deep gold inside. 27

'Blue Bird'—outer sepals violet with white margin and inner sepals white with bronze base. 171

'Blue Pearl'—soft hyacinth flowers, blue outside, white inside. 27

'Cream Beauty'—creamy white flowers. 27, 122

'E.A. Bowles'—lemon-yellow flowers with bronze-green bases and purplish-brown margins. 171

'Gypsy Girl'—buttercup-yellow flowers striped with purplish-brown. 27, 122

'Lady Killer'—deep violet petals bordered with white, lilac inside. 27, 122

'Saturnus'—petals deep yellow with three purple bronze feathers. 54

'Yellow Bird'—rich golden-yellow flowers. 122

Crocus corsicus—petals lilac feathered deep purple, blooms in spring. 122

Crocus etruscus—lilac flowers with a yellow throat.

'Zwanenburg'—flowers lilac inside, silver with blue feathering outside. 122

Crocus fleischeri—cream flowers with dark purple at base and scarlet styles. 54

Crocus goulimyi—intense blue flowers flushed with pink, blooms in fall. 171

Crocus imperati 'De Jager'—outer petals amber yellow with dark purple feathers, inner petals heliotrope with purple stripes. 171

Crocus korolkowii—golden-yellow flowers with bronze centers shaded with russet-bronze on the outside.

Crocus kotschyanus (zonatus)—rose-purple flowers with a yellow throat, bloom in the fall. 54, 122, 171, 177

Crocus medius—deep lilac-purple with darker stripes, scarlet styles and yellow anthers, blooms in the fall. 171

'Eco Swirl'—lilac flowers with dark purple streaks. 54

Crocus minimus—outside petals have a pale lilac edging with dark purple feathers, inside petals are lilac with an orange stigma. 171

Crocus salzmannii—star-shaped soft lilac flowers with yellow throat and anthers, orange stigma, blooms in fall. 171

Crocus sativus—violet-purple flowers with a bright orange stigma, blooms in fall. 122, 171, 177

Crocus sieberi—starlike flowers of dark purple to white with an orange throat in winter. 171

'Violet Queen'—amethyst-violet flowers with a yellow veined in green base. 122

Crocus speciosus—violet-blue flowers with orange stigmas, blooms in fall. 27, 122, 171, 177

'Albus'—pure white flowers in fall. 122, 171

Crocus tomasinianus 'Whitewell Purple' (Ruby Giant)—lavender shading to rich purple on petal tips, white throat, blooms in spring. 27, 171

Crocus vernus—flowers white to lilac often feathered darker purple on the outside in early spring.

'Enchantress'—porcelain-blue flowers. 122

'Paulus Potter'—shiny reddish-purple flowers. 122

'Purpurea Grandiflora'—deep purple. 122

'Snow Storm'—pure white flowers. 122

'Striped Beauty'—lilac striped with white flowers. 122

'Yellow Mammoth'—golden-yellow flowers. 122

Cyclamen *balearicum*—4″ HT, small white flowers with pink veins and marbled leaves in spring. 109

Cyclamen cilicium—4″ HT, rose-pink flowers with dark crimson blotch at petal base in fall, leaves marbled. 95, 109, 122, 139, 145, 171, 173

intaminatum—pale pink flowers. 109

Cyclamen coum (atkinsii)—4″ HT, pink to carmine flowers in spring, leaves round with pale green markings. 109, 139, 145, 171, 173

'Album'—flowers pure white with raspberry blotches at petal base. 139

caucasicum—larger flowers, leaves heart-shaped. 109, 139

coum (hiemale)—139

macka—white variegation in leaf. 109

'Pewter Leaf'—rose-pink flowers with silvery leaves. 109

'Ufra'—109

Cyclamen cyprium—4″ HT, white flowers with pinkish petal blotches in fall. 139

Cyclamen graecum—4″ HT, pale pink flowers with lilac streaks and reddish blotches at base in fall. 139

Cyclamen hederifolium (neapolitanum)—pink with reddish streaking to base, leaves marbled, blooms in fall. 3, 37, 95, 109, 122, 133, 137, 139, 145, 171, 173

'Album'—white flowers. 139, 145

'Carpet of Pearls'—white flowers. 3, 161

'Carpet of Roses'—pink flowers. 3

'Pink Carpet'—pink flowers. 161

Cyclamen libanoticum—5″ HT, pink and white flowers with red blotch at base in spring, leaves dark green with lighter green, wavy edges, tender. 109

Cyclamen mirabile—pink flowers with twisted petals and fringed tips in fall, young leaves are bright pink. 109

Cyclamen persicum—pink or white flowers with twisted petals, fragrant, the true "florist's cyclamen," tender. 109

Cyclamen pseudibericum—purplish-carmine flowers in winter, olive-green leaves. 109

Cyclamen purpurascens (europaeum and *fetrense)*—4″ HT, lilac pink flowers in fall, leaves rounded with light green splotches. 133, 139, 145

Cyclamen repandum—4″ HT, lavender-pink flowers flushed with darker blotches at leaf base in spring, green marbling on leaves. 109, 139

Dierama *pulcherrimum*—4′ HT, purple-pink and rose bells on arching wiry stems in late summer, leaves irislike grassy green, tender. 34

Endymion *hispanicus (Scilla hispanica)*—15″ HT, mixed flowers of pink, blue, and white in spring, leaves grassy green, dormant in summer, tolerates partial shade. 27, 177

'Alba Maxima'—pure white flowers. 122, 171

'Blue Queen'—blue flowers. 177

'Excelsior'—deep blue. 122, 171

'Rosabella'—pink flowers. 122, 177

'White Triumphator'—small white flowers. 177

Eranthis hyemalis—3-6″ HT, yellow flowers in late winter, dark green cleft leaves, dormant by early summer. 27, 83, 122, 171, 177

Eremurus himalaicus—3′ HT, pure white spiky flowers, requires excellent drainage. 139, 171

Eremurus x *isabellinus* 'Shelford Hybrid'—6′ HT, mixed flowers of pink, yellow, white, orange and coppery yellow, requires excellent drainage. 139, 177

Eremurus 'Pastel Hybrids'—6′ HT, mixed flowers of pastel colors. 171

Eremurus robustus—7-10′ HT, clear pink flowers with a brownish blotch at the base in late spring, requires excellent drainage. 39, 49, 139

Eremurus stenophyllus—2-3′ HT, spikes of yellow flowers in early summer, leaves die quickly after flowering, requires excellent drainage. 139, 171

Erythronium: All prefer partial shade and go dormant in midsummer.

Erythronium albidum—10″ HT, lilylike blue to pink to white flowers tinged with yellow in center in spring, broad pointed basal leaves. 25, 66, 133, 139, 143

mesochoreum—leaves narrower and does not produce offsets. 139

Erythronium americanum—10″ HT, yellow flowers spotted brown with brownish-red striping on petal backs, leaves green, mottled with white and red-brown. 29, 66, 139

Erythronium citrinum—6″ HT, cream to pale yellow flowers in spring, mottled leaves. 145

Erythronium dens-canis—4-6″ HT, pink to purple flowers in spring, variegated leaves, mottled with brown. 145

Erythronium grandiflorum—1′ HT, butter-yellow flowers with purple-brown anthers, leaves shining green, requires dryer soil in summer when dormant. 145

Erythronium hendersonii - 10″ HT, pinkish-lilac flowers with a purple center and purple anthers, leaves green, mottled with white and brown. 139

Erythronium howellii—6″ HT, cream and yellow center, leaves mottled. 145

Erythronium multiscapoideum—8″ HT, white and pale yellow flowers with greenish yellow at the base, mottled leaves. 139

Erythronium 'Pagoda'—1′ HT, yellow-green flowers, large wavy mottled white leaves. 27, 122, 139, 145, 171, 177

Erythronium revolutum—9-12″ HT, shades of pink drooping flowers with yellow anthers in spring, mottled leaves, requires moist organic soil. 139

'Rose Beauty' ('Rosea')—16″ HT, deep rose flowers, leaves heavily mottled. 139, 145

'White Beauty'—white flowers flushed with yellow. 122, 145, 171, 177

Erythronium tuolumnense—1′ HT, small deep yellow flowers, shiny green leaves. 139, 171

Fritillaria: prefer moist soils, will tolerate light shade and bloom in spring.

Fritillaria dasyphylla—6″ HT, nodding bell-shaped flowers maroon outside, yellow inside with recurved petals. 171

Fritillaria imperialis—4′ HT, flowers have a foxy odor.

'Aurora'—drooping yellow bells on grassy stems.

'Lutea Maxima'—golden-yellow flowers. 27, 122, 171, 177

'Orange'—orange flowers

'Rubra Maxima'—orange-red flowers.

Fritillaria meleagris—10″ HT, flowers checkered with maroon and purple on nodding bells, leaves grasslike. 27, 122, 139, 171, 177

'Alba'—10″ HT, white flowers. 139, 177

Fritillaria persica—3′ HT, bell-shaped maroon

flowers, blue-green grassy leaves. 177

'Adiyaman'—27, 122, 171, 177

Fritillaria pudica—6″ HT, butter-yellow bell flowers, leaves reddish tinged green, grasslike, needs well drained sandy soil and no water after flowering, good for pot culture. 145

Galanthus *nivalis*—6″ HT, hanging white petals with greenish centers, blooms in spring, leaves grasslike, prefers good soil. 11, 27, 122, 171

'Flore Pleno'—double flowers. 27, 171, 177

'Mighty Atom'—11

'Simplex'—larger single blooms. 177

'Viridapicis'—larger blooms with with greenish petal tips. 171

Galtonia *candicans*—4′ HT, white fragrant bells in summer, gray-green straplike leaves which die back in late summer. 37, 49, 139

Geranium *stapfianum*—6″ HT, pink flowers in early summer, mottled leaves. 145

Gladiolus *x gandavensis*—2.5′ HT, small yellow flowers in summer, stiff irislike leaves. 173

Gladiolus palustris—1′ HT, small pink flowers in summer, irislike leaves. 173

Hedychium *coronarium*—2′ HT, white fragrant flowers in summer, broad green leaves, tender. 41, 171

Helonias *bullata*—1.5′ HT, spikes of small pink fragrant flowers in spring, straplike green, tufted rosettes of leaves, tuberous rhizome, requires moist to wet soils. 145

Heloniopsis *orientalis*—10″ HT, small nodding pink lilylike flowers in spring, green rosettes of leaves, rhizome. 139, 145

Hemerocallis: have tuberous roots, arching bright green leaves and will grow in partial shade or full sun.

Hemerocallis collection of named hybrids: 3, 9, 27, 29, 37, 39, 41, 45, 49, 52, 54, 65, 67, 77, 97, 122, 133, 137, 143, 157, 159, 169, 171, 177

Hemerocallis aurantiaca—3′ HT, orange flowers in summer. 109

Hemerocallis fulva—4′ HT, orange to buff flowers in midsummer, rhizomatous. 21, 66, 173

'Maculata'—paler flowers with a dark central band on petals, not invasive. 173

Hemerocallis liliosphodelus (flava)—2.5′ HT, yellow fragrant flowers in late spring, rhizomatous. 173

Hemerocallis middendorffii—1.5′ HT, yellow to orange fragrant flowers in late spring.

esculenta—similar to species, but flower buds not as tightly clustered. 173

Hemerocallis minor—1.5′ HT, yellow fragrant flowers in spring. 173

Hermodactylus *tuberosus (Iris tuberosa)*—1′ HT, olive-green flowers in spring, irislike leaves, requires well drained soil. 171

Hyacinth collection—1.5′ HT, mixed flowers of pink, red, yellow and white in spring, thick grassy leaves. 27, 122, 171, 177

Hymenocallis *caroliniana (occidentalis)*—1.5′ HT, white daffodillike fragrant flowers in summer, straplike leaves, requires moist to wet soils, tender. 137, 173, 181

'Zwanenburg'—larger flowers. 171

Hymenocallis harrisiana—10″ HT, green flowers with white lobes in summer, dark green oval leaves. 54

Hypoxis *hirsuta*—10″ HT, small yellow daffodillike flowers in spring, slender grasslike leaves, will grow in full sun to partial shade. 37, 49, 137, 139, 145, 173

Ipheion *uniflorum* 'Wisley Blue'—6″ HT, white flowers tinged with violet in spring, green grasslike leaves, will grow in full sun or partial shade. 122, 139, 171

Iris: have rhizomes or bulbs and bloom in the spring unless noted. *Iris arenaria*—6″ HT, orange-yellow flowers, grasslike leaves, requires excellent drainage. 133

Iris, bearded collection: 9, 11, 21, 27, 37, 39, 83, 97, 107, 122, 159, 169, 171

Iris brevicaulis—1.5′ HT, bright blue flowers, requires a moist rich soil. 45, 181

Iris bucharica—1.5′ HT, yellow to white flowers, arching folded fanlike foliage, requires good drainage. 122, 171

Iris bulleyana—2′ HT, violet, gold and white flowers in early summer. 29

Iris chrysographes—2.5′ HT, mixed flowers of violet, blue, purple and gold in early summer, grasslike leaves, moist rich soils. 3, 29, 45, 121

Iris clarkei—2.5′ HT, blue and white flowers in summer, grasslike leaves, glossy above, glaucous beneath. 29, 45, 121

Iris cristata (marbigo)—6″ HT, pale blue to navy flowers with a yellow and white crest, lance-shaped leaves, will grow in full sun or partial shade, requires moist organic soil. 9, 21, 29, 25, 37, 45, 49, 66, 73, 91, 113, 117, 120, 121, 123, 137, 139, 143, 144, 145, 157, 159, 171, 181

'Abbey's Violet'—deep violet-blue flowers with a yellow and white crest. 133, 145

'Alba'—white flowers. 9, 37, 45, 113, 133, 137, 144, 145, 159, 171, 173, 181

'Baby Blue'—4″ HT, light purple-blue flowers with a yellow and white crest. 145

'Butterflies'—5″ HT, light blue flowers with a yellow and white crest. 144

'Dark Blue'—dark blue flowers. 139

'Eco Little Bluebird'—bright blue larger flowers with a yellow and white crest. 137, 173

'Eco Royal Ruffles'—violet flowers with a ruffled white crest. 137

'Shenandoah Sky'—light blue flowers. 9, 37, 137, 144

'Summer Storm'—deep blue flowers. 9, 37, 137, 165

'Vein Mountain'—pale blue flowers with orange crests outlined in purple. 173

Iris danfordiae—6″ HT, yellow flowers with olive-green spotting, thin gray-green leaves disappearing by midsummer, requires full sun and well-drained soil. 27, 177

Iris delavayi—4′ HT, purple flowers with a white crest in summer, thin gray-green leaves. 29

Iris douglasiana—2′ HT, rosy-lilac flowers marked with white, yellow and violet, rich green arching leaves, will grow in full sun or partial shade, requires moist soil. 3, 61, 139

Iris dykesii—1.5′ HT, dark violet flowers with a yellow stripe, thin grasslike dark green leaves. 29, 45

Iris foetidissima—1.5′ HT, lilac flowers with a green crest in early summer, rich dark green leaves, evergreen, bright orange seeds, requires partial shade. 9, 54, 171

Iris forrestii—2′ HT, lemon-yellow flowers in early summer, bright rich green narrow leaves. 29, 54

Iris fulva—2′ HT, brownish-red flowers in summer, rich green broad arching leaves, requires moist soil. 45, 61

Iris giganticaerulea—4′ HT, flatish blue flowers with yellow streaks in summer, linear narrow glaucous leaves, requires moist rich soil. 173

Iris gracilipes—8″ HT, delicate blue flowers with a yellow crest, graceful arching sword-shaped leaves, requires partial shade and moist organic soil. 173

'Alba'—white flowers with a yellow crest. 173

Iris graminea—1.5′ HT, rosy-purple fragrant flowers with a violet blue crest in summer, dark green narrow leaves. 45, 121

Iris histrioides 'Major'—8″ HT, deep blue flowers with a golden crest, green grasslike leaves that disappear by midsummer. 27

Iris innominata—8″ HT, various flowers of lavender, magenta, purple, gold and cream,

thin glossy dark green leaves, prefers dry summer conditions, requires partial shade and good drainage, tender. 61, 139, 145

Iris japonica—2′ HT, lavender-blue flowers with yellow crests in summer, broad dark green leaves. 54, 139

Iris kaempferi (ensata)—3′ HT, mixed flowers of blue, violet and white in early summer, ribbed bright green leaves, requires damp acid soils. 3, 29, 65, 91, 97, 133, 173

'Rainbow Higo Mix'—3′ HT, pastel color mix. 122, 171

Iris kaempferi collection of named hybrids: 9, 21, 37, 39, 49, 83, 95, 137, 139, 153, 159, 165, 177

Iris lacustris—4″ HT, blue flowers, lance-shaped leaves, will grow in full sun or partial shade and requires moist soil. 45, 137, 145

'Alba'—white flowers. 145

Iris laevigata—1.5′ HT, lavender-blue flowers in summer, broad soft green leaves, requires damp to wet soils. 45, 83, 173

'Alba'—white flowers. 29

'Colchesterensis'—deep blue flowers with a white edge. 29, 54

'Monstrosa'—medium blue flowers with a white border. 20

'Regal'—rose-magenta flowers. 29, 45

'Royal Cartwheel'—navy-blue flowers with a purple crest. 29

'Semperflorens'—deep bluish-violet flowers. 29

Iris macrosiphon—1′ HT, cream, yellow, pale or deep violet flowers in summer, linear leaves, requires well drained soil. 61, 121

Iris minutaurea—4″ HT, small yellow flowers with purple spots, slender dark green leaves. 54

Iris orientalis—4′ HT, pure white flowers marked with yellow in summer, stiff sword-shaped leaves. 45, 65, 153

Iris pallida—3′ HT, fragrant bearded flowers of light lavender-blue and white with golden markings in early summer, grayish leaves, requires full sun. 45

'Albo-variegata' ('Variegata' and 'Zebra')—leaves streaked with cream and white. 9, 29, 37, 139, 171

'Dalmatica'—wider leaves. 9

Iris prismatica—2′ HT, pale lilac flowers with green crests and purple veins, leaves narrow, requires moist soil and full sun. 29, 54, 61, 121, 139, 173, 181

'Polly Spout'—1.5′ HT, larger flowers with primrose yellow markings. 173

'Rosea'—2′ HT, flowers with reddish-violet veins. 173

Iris pumila collection of named hybrids: 8″ HT. 21, 63, 83, 121, 137, 141, 159

Iris reticulata—8″ HT, violet purplish-blue fragrant flowers with yellow and white markings in late winter to early spring, thin grasslike leaves that disappear by midsummer. 139, 171

'Cantab'—light blue flowers with white and yellow markings. 27, 139, 177

'Clairette'—light blue flowers with a dark blue crest. 139

'Joyce'—large violet-blue flowers with a yellow crest. 139, 177

'J.S. Dijt'—red-purple flowers with a yellow crest. 27, 139

'Natascha'—white tinted blue flowers with a yellow crest. 27

'Pauline'—deep purple-blue flowers with a yellow crest. 139

'Violet Beauty'—deep violet flowers with deep golden markings. 27, 177

Iris x *robusta*—2.5′ HT, violet flowers in early summer, smooth broad leaves, requires full sun and moist to wet soils. 45

Iris sanguinea—1.5′ HT, blue-purple flowers with a white crest in early summer, slender arching leaves. 3, 45, 54, 121, 161, 173

'Kamayama'—deep purple flowers with a white crest. 41

'Nana Alba'—10″ HT, white flowers. 173

Nana—1′ HT, reddish-purple flowers. 173

Iris setosa—1.5′ HT, deep purple flowers with white centers veined yellow in early summer, light green leaves, requires full sun and moist soil. 45, 61, 83, 109, 121, 139, 173

'Alba'—white flowers. 159, 173

Nana—8″ HT, blue-purple flowers, tufted grasslike leaves. 145, 159, 161, 173

Iris sibirica—2.5′ HT, blue flowers in early summer, tufted grasslike leaves, will grow in full sun to partial shade and average to moist soils. 45, 63, 121

Iris sibirica collection of named hybrids: 9, 21, 27, 29, 37, 45, 49, 65, 77, 83, 109, 137, 139, 153, 157, 159, 165, 169, 171, 177

Iris suntensii—1.5′ HT, white flowers with blue veins and a deep blue crest in early summer, slender pointed leaves. 45

Iris spuria—2.5′–5′ HT, blue to purple or lilac flowers with yellow markings in early summer, requires dry summer conditions. 45, 63, 83

'Shelford Giant'—4.5′ HT, white and yellow flowers. 37, 139

Sunny Day—4′ HT, golden-yellow flowers. 37

Iris tectorum—1′ HT, lilac flowers with white crests and purple veins in early summer, bright green fan-shaped leaves, will grow in full sun or partial shade. 9, 37, 45, 95, 133, 137, 159, 171, 173, 181

'Album'—pure white flowers. 9, 37, 77, 95, 109, 133, 137, 159, 171, 173, 181

Variegata—leaves striped with green. 29

Iris tenax—1.5′ HT, delicate lilac to violet flowers, slender tough fibrous leaves. 61, 139, 173

Iris tridentata—2′ HT, violet flowers with yellow crests in summer, thin leaves, requires moist to wet soils. 41, 173

Iris verna—8″ HT, brilliant blue flowers with an orange blotch, evergreen pointed leaves, requires partial shade and moist soil. 29, 41, 66, 77, 133, 139, 144, 145

Iris xiphioides—2′ HT, violet-blue flowers in summer, arching blue-green thin leaves, requires full sun and well-drained soil. 122, 17

Iris xiphium collection of named hybrids: 1.5′ HT, yellow, blue and violet flowers in early summer, requires full sun and well-drained, but moist soil. 27, 122, 171, 177

Lapeirousia laxa—10″ HT, red and blue flowers in summer, irislike leaves, tender. 109

Leucojum aestivum—1.5′ HT, white bell flowers with green tips in early spring, dark green thin leaves disappearing by midsummer, will grow in partial shade or full sun and requires moist to wet soils. 27, 41, 139, 171

'Gravetye Giant'—2′ HT, robust form of species. 11, 177

Leucojum autumnale—6″ HT, pure white small bells in late summer through fall, thin grasslike leaves. 145

Leucojum vernum—8″ HT, white bells with green tips in late winter, dark green straplike leaves disappearing by midsummer, will grow in full sun or partial shade and requires moist soils. 27, 122

carpathicum—8″ HT, white bells with yellow tips. 145

Lilium: all prefer moist organically enriched soil and full sun, leaves vary from lance-shaped to grasslike.

Lilium—Asiatic collection—4′ HT, mixed yellow, pink, orange and red upward-facing flowers in summer. 21, 27, 29, 37, 39, 63, 107, 122, 159, 171, 177

Lilium amabile—3′ HT, drooping red-orange dark spotted flowers in late spring. 139

'Luteum'—yellow flowers. 139

Lilium auratum—6′ HT, bowl-shaped, fragrant, upward-facing flowers, white with crimson spots and central gold stripe on each petal, blooms in summer. 171

Lilium—Aurelian and Trumpet collection—4-8′ HT, trumpet-shaped fragrant flowers with reflexed petals of yellow, orange, gold, and purple, blooms in summer. 21, 27, 29, 37, 63, 107, 122, 139, 159, 161, 171, 177

Lilium bulbiferum—4′ HT, bowl-shaped upward-facing flowers of orange to red with a central orange patch, blooms in summer. 83

Lilium canadense—5′ HT, bell-shaped drooping flowers of yellow, orange and red with dark spots, blooms in summer, requires moist to wet acid soil. 9, 139, 173

editorum—red flowers, tolerates dryer soil. 139

Lilium candidum—5′ HT, pure white fragrant upward-facing flowers in early summer. 27, 37, 122, 139, 171, 177

Lilium cernuum—2′ HT, lilac nodding flowers in summer. 139

Lilium concolor partheneion—2′ HT, vermilion upward-facing flowers with dark spots. 173

Lilium davidii—5′ HT, red drooping flowers with dark spots. 139

Lilium formosanum—7′ HT, white trumpet flowers stained purple outside, blooms in summer. 109, 173

Lilium hansonii—4′ HT, orange-yellow drooping fragrant flowers with purple spots, blooms in late spring. 139

Lilium henryi—8′ HT, orange drooping flowers with brown spots, blooms in summer. 37, 83, 139

Lilium lancifolium (tigrinum)—6′ HT, orange spotted purple drooping flowers. 27, 83, 171

'Album'—white flowers. 159

'Rubrum'—red flowers. 159

'Splendens'—larger red flowers and bolder spots. 83, 159

'Yellow Star'—yellow flowers. 159

Lilium leichtlinii tigrinum (maximowiczii)—8′ HT, orange-red nodding flowers with purple-brown spots in summer. 139

Lilium longiflorum 'Shova'—3′ HT, white fragrant flowers with a green throat in summer. 122

Lilium martagon—5′ HT, purplish-pink dark spotted flowers in late spring. 37, 83, 121, 171

album—white flowers. 171

Lilium—Oriental Collection—4-6′ HT, pastel and deep red fragrant flowers usually spotted with reflexed petals in late summer. 21, 27, 29, 37, 63, 107, 122, 139, 159, 161, 171, 177

Lilium pardalinum—7′ HT, red, yellow or orange flowers with brown spots, requires moist to wet soils. 61

'Giganteum'—yellow flowers tipped bright red. 139

Lilium philadelphicum—3′ HT, orange-red upward facing flowers with brown spots in early summer. 61, 83, 139

Lilium pumilum—2′ HT, coral-scarlet fragrant flowers in early summer. 109, 139, 171

'Golden Gleam'—2′ HT, golden-yellow flowers. 139

Lilium regale—5′ HT, white fragrant pendent flowers with a yellow throat and purple shading on the outside, blooms in early summer. 27, 83, 107, 139, 159, 171

Lilium speciosum—5′ HT, white fragrant nodding flowers suffused with pink or red, reflexed petals, blooms in late summer. 9

'Album'—5′ HT, pure white flowers. 37

'Crimson Glory'—5′ HT, rose spotted flowers spotted with dark red and white edges. 139

Grand Commander'—4′ HT, crimson-red flowers dark spotted wtih white petal margins. 3″, 107

Imperial Crimson'—5′ HT, white flowers with crimson stripes and spotting. 171

Imperial Gold'—5′ HT, white with golden-yellow stripes and crimson spotting. 171

Rubrum'—5′ HT, carmine-red flowers spotted with dark red with white petal tips. 3″

Uchida'—1′ HT, rose-crimson flowers with white edges and dark red spots. 3″, 159

White Glory'—5′ HT, white flowers. 139

Lilium superbum—8′ HT, bright yellow to orange flowers spotted with maroon in summer, requires moist to wet acid soils. 9, 3″, 66, 127, 139, 159, 171

Lilium x *testaceum*—6′ HT, soft apricot flowers with orange stamens in summer. 171

Lilium vollmeri—3′ HT, yellow, reddish and orange flowers spotted with maroon in summer, requires moist to wet soils. 61

Lycoris albiflora—1′ HT, ivory flowers tipped with peach in fall, grasslike leaves, tender. 122, 171

Lycoris radiata—1.5′ HT, bright crimson flowers in fall, grasslike leaves, tender. 41, 122, 171

Lycoris squamigera—2.5′ HT, fragrant trumpet flowers of lavender and pink in spring, grasslike leaves which disappear by summer. 2″, 3″, 41, 63, 109, 122, 137, 171, 177

Muscari prefer full sun to light shade, well-drained soil, bloom in spring, have blue-green grasslike leaves.

Muscari armeniacum—7″ HT, purple-blue fragrant flower spikes, leaves appear in fall and die back the following summer. 2″, 122, 139, 177

Blue Spike'—10″ HT, large flower spikes of clear blue. 2″, 122, 171, 177

Early Giant'—10″ HT, cobalt blue. 171

White Beauty'—8″ HT, white flowers. 122, 171

Muscari azureum—6″ HT, pale blue flowers in early spring. 122, 139, 177

Muscari botryoides 'Album'—7″ HT, white flowers in small flower clusters. 2″, 139, 177

Muscari comosum 'Plumosum'—8″ HT, violet flowers in a feathery spike. 2″, 171

Muscari neglectum—9″ HT, black-purple flowers with a white rim. 171

Narcissus: will grow in full sun to light shade, require moist organic soil, bloom in spring and have grassy green leaves which disappear by summer.

Narcissus collection of named hybrids: 2″, 54, 122, 139, 171, 177

Narcissus asturiensis (minimus)—4″ HT, small deep yellow flowers in late winter. 2″, 139

Narcissus bulbocodium conspicuus—6″ HT, deep yellow funnel-shaped flowers, leaves appear in fall. 2″, 54, 77, 122

Narcissus cyclamineus—1′ HT, nodding deep yellow frilled cup, petals fully reflexed, dark green leaves. 122

Narcissus juncifolius—4″ HT, very fragrant bright yellow flower clusters, thin rushlike leaves. 139

Narcissus obvallaris—8″ HT, canary-yellow flowers. 2″

Narcissus x *odorus* 'Rugulosus'—10″ HT, clustered fragrant golden-yellow flowers, thin rushlike leaves. 2″

Narcissus poeticus 'Actea'—1.5′ HT, fragrant pure white flowers with a yellow cup edged with deep orange. 2″, 177

Narcissus romieuxii—8″ HT, similar to *N. bulbocodium*, but has sulphur yellow flowers. 54

Narcissus triandrus—1′ HT, pendent fragrant white or yellow flower clusters with reflexed curving petals.

'April Tears'—8″ HT, clear yellow flowers. 177

'Hawera'—8″ HT, clear lemon-yellow flowers. 27, 171

'Liberty Bells'—1′ HT, deep lemon-yellow flowers. 177

'Thalia'—pure white flowers. 27, 122, 139, 171, 177

triandrus (albus and 'Angel's Tears')—8″ HT, pure white flowers. 139, 171, 177

Nemastylis acuta—1.5′ HT, blue clustered flowers in spring, narrow irislike leaves, tender. 11

Nerine *bowdenii*—2′ HT, pink spidery flowers in fall, straplike green leaves produced after flowers, tender. 171

Ornithogalum *nutans*—1.5′ HT, silvery gray-green flowers inside and green and white outside, blooms in spring, daffodillike leaves. 177

Ornithogalum umbellatum—8″ HT, white and green flowers in late spring, grasslike leaves, naturalizes easily, may be a serious weed. 83, 122, 171, 177

Oxalis *acetosella* 'Rosea'—3″ HT, glowing pink flowers in summer, cloverlike leaves in threes, rhizomatous, requires good organic soil. 133

Oxalis adenophylla—4″ HT, cup-shaped soft pink flowers with a crimson eye in early summer, fan-shaped rounded soft gray-green leaves, requires partial shade. 83, 139, 145

'Pink Carpet'—4″ HT, lilac-pink flowers. 27

Oxalis depressa—4″ HT, bright rose-pink flowers in early summer, green rounded leaves. 145

Oxalis oregana—6″ HT, pink, white and rose flowers in spring, twice-lobed leaves, requires partial shade. 3, 139

'Alba'—white flowers. 139

Oxalis rubra—1′ HT, bright pink flowers with rose-pink center in spring, green twice-lobed leaves, tender. 117

Oxalis versicolor 'Candycane'—8″ HT, blush petals edged with pink in fall, resembles a candycane when unfolding, tender. 122, 171

Oxalis violacea—8″ HT, bright cup-shaped flowers in spring and fall, green leaves in threes. 133

Pancratium *maritimum*—1.5′ HT, white fragrant flowers in early summer, blue-green straplike leaves, tender. 171

Paradisea *liliastrum*—2′ HT, white flowers in spring, broad gray-green straplike leaves. 49

Lilium auratum

Pardancanda norrisii—3′ HT, mixed flowers of red, pink, and orange in summer, sword-shaped leaves, black seed pods. 37, 49, 65, 122, 141, 157, 159, 169, 171, 175, 183

Polianthes tuberosa—3.5′ HT, white trumpet-shaped fragrant flowers in late summer, straplike leaves. 171

Puschkinia scilloides—6″ HT, soft blue flowers striped with dark blue in early spring, grasslike leaves dormant in summer. 27, 122, 177

Ranunculus asiaticus—1.5′ HT, white, pink and crimson flowers in early spring, shiny green divided and toothed leaves, tender.

'Superbissimus'—mixed semidouble flowers of red, orange, pink, yellow and white. 177

Rhodohypoxis baurii—3″ HT, deep pink starlike flowers in late spring, grasslike leaves, prefers full sun, sandy soil and rock garden conditions. 3, 115

'Tetra Hybrids'—6″ HT, large flowers and leaves. 145

Romanzoffia sitchensis—10″ HT, white bell-shaped flower clusters in spring, scalloped rounded leaves dormant in summer, requires humus-rich soil and shade. 145

Schizostylis coccinea—2′ HT, deep crimson flowers in fall, fleshy roots and irislike leaves, requires moist to damp fertile soils.

'Major'—dark red flowers. 141

'Mrs. Doherty'—rose flowers. 141

'November Cheer'—glowing pink flowers. 171

'Oregon Sunset'—watermelon-pink flowers. 171

Scilla bifolia 'Rosea'—6″ HT, star-shaped rose flowers in early spring. 171

Scilla litardierei—10″ HT, blue flowers in late spring, grasslike leaves dormant in summer. 11

Scilla numidica—pink flower spikes in fall. 133

Scilla scilloides (chinensis)—1′ HT, deep pink, rose, and blue flower spikes edged with green in late summer, leaves emerge in the spring and are dormant in fall. 11, 54, 173

Scilla siberica—6″ HT, deep blue nodding flowers in early spring. 'Spring Beauty'—deep blue larger flowers. 122, 171, 177

Spiranthes cernua—1.5′ HT, fragrant white flowers in late summer, narrow basal leaves. 66

Sternbergia lutea—6″ HT, golden-yellow flowers in early fall, thin straplike leaves, dormant in summer. 145

'Major'—larger flowers. 122, 171

Streptopus roseus—2.5′ HT, rose-to-purple flowers, finely pubescent leaves. 139

longipes—120

Tipularia discolor—10″ HT, pendent small brown and white flower spikes in midsummer, evergreen heart-shaped leaves spotted with purple, prefers full sun and moist humus-rich soil. 173

Tofieldia calyculata—10″ HT, yellowish flower spikes in summer, narrow leathery evergreen leaves in fans, rhizomatous, prefers full sun and boggy acid soils. 173

Tofieldia coccinea—2″ HT, small white flower spikes in spring, small evergreen leaves in fans, prefers boggy acid soils. 173

Tulbaghia violacea—2.5′ HT, bright violet star-shaped flower clusters in summer, thin grasslike leaves with an onion scent, tender. 54

'Variegata' ('Silver Lace')—glaucous leaves striped with white. 37, 54, 144

Tulipa collection of named hybrids: 27, 122, 171

Tulipa acuminata—15″ HT, scarlet and yellow flowers with upright pointed narrow twisted petals in midspring, gray-green spear-shaped leaves. 171

Tulipa batalinii 'Bright Gem'—6″ HT, cuplike soft yellow flowers flushed with buff-cinnamon in midspring, narrow gray-green leaves. 177

Tulipa bakeri 'Lilac Wonder'—8″ HT, cup-shaped lilac-pink flowers with an orange-yellow center, gray-green narrow leaves. 27

Tulipa chrysantha—6″ HT, orange-yellow flowers, red on the outside, in midspring, narrow glaucous leaves. 139

'Tubergen's Gem'—8″ HT, taller larger flowers. 139, 171

Tulipa clusiana—10″ HT, white striped flowers with red on the outside in midspring, narrow blue-green leaves. 27, 139, 177

'Stellata'—10″ HT, larger flowers. 171

Tulipa eichleri—10″ HT, scarlet flowers with yellow striping on the outside petals in early spring, glaucous leaves. 139

Tulipa fosteriana collection—1.5′ HT, large flowered mix of yellow and red flowers in early spring, wide glaucous leaves, some mottled with maroon. 27, 122, 171, 177

Tulipa greigii—1.5′ HT, large conical flowers in early spring, glaucous pointed striped leaves mottled with brown and maroon.

'Goldwest'—clear yellow flowers. 171

'Plaisir'—carmine-red flowers with a pale yellow edge. 27

'Princess Charmant'—carmine-red fragrant flowers with flared petals. 27

'Red Riding Hood'—brilliant scarlet-red flowers. 27, 139

'Sweet Lady'—deep salmon-pink flowers. 27, 171

Tulipa humilis—6″ HT, intense violet-pink flowers with a blue to dark purple base in early spring, narrow glaucous leaves. 27

Tulipa kaufmanniana—6″ HT, soft yellow flowers flushed with rosy-red outside in early spring, creamy white and gold inside, broad glaucous leaves. 27

Tulipa kolpakowskiana—8″ HT, outer petals deep yellow streaked with red, pure yellow inside, blooms in early spring, narrow glaucous crinkled leaves. 171, 177

Tulipa linifolia—6″ HT, large radiant crimson flowers with pointed petals and a black center, narrow glaucous leaves. 27, 139, 177

Tulipa marjolettii—1.5′ HT, ivory-white flowers with flushed red edges in midspring, narrow pointed leaves. 177

Tulipa praestans 'Fusilier'—8″ HT, orange-scarlet clustered flowers in early spring, broad gray-green leaves. 27, 171, 177

Tulipa pulchella 'Violacea'—6″ HT, soft rosy-lavender flowers with a yellow throat in early spring, strap-shaped leaves. 139, 171

Tulipa saxatilis—8″ HT, rosy-lilac flowers with a yellow base in clusters in late spring, green straplike leaves. 171

Tulipa sylvestris—14″ HT, yellow fragrant flowers with a soft green reverse in midspring, straplike gray-green leaves. 171

Tulipa tarda (dasystemon)—6″ HT, open brilliant yellow flowers edged with white in midspring, gray-green narrow leaves. 27, 177

Tulipa turkestanica—clustered white flowers flushed with soft violet and an orange-yellow throat in early spring, glaucous narrow leaves. 139, 171

Tulipa urumiensis—5″ HT, clustered clear yellow flowers with outer petals tinted with olive and red, narrow gray-green leaves. 171

Buying Tips for Herbaceous Plants

All of the nurseries listed in this manual are mail-order retail nurseries or wholesale nurseries that ship long distances. Wholesale nurseries are not equipped to deal directly with the public, except where noted. If you desire a plant that is available only from a wholesale source, please ask your local nurseryman to order it for you. When ordering plants by mail, it is best to specify a shipping date according to the best planting time in your area. Most plants are dug in the fall and shipped that season or the following spring. Although spring is the traditional planting season, fall planting should not be ruled out since it has proven very beneficial for many species.

Most plants ordered through the mail will take a season to catch up to the established plants in your garden. You are basically purchasing bareroot plants and they will not arrive like the plants that you buy at the local garden center. This is not to say that they are less hardy. The benefits of buying by mail are that you have a much wider selection and the prices are usually lower so you can afford to try new things. If you are looking for an instant garden, your efforts would best be spent at a local nursery that carries mature plants.

There is much concern about not purchasing plants collected from the wild. Generally, a catalog states whether or not the nursery propagates the native species they offer. If they do not state whether or not they propagate, ask them. It is only through the demands of their customers that nurseries will stop collecting plants from the wild. For more information about this matter and a list of nurseries that do propagate their own plants, contact the New England Wildflower Society, Framingham, MA 01701.

Wholesale and Retail Nurseries

Below is the list of wholesale and retail nurseries used in this source manual. The dollar amount listed is the cost of the catalog and DFO means that this amount will be deducted from your first order. All of the nurseries listed ship through parcel post or United Parcel Service.

3 Alpenflora Gardens (1970)
17985 40th Avenue
Surrey, BC V3S 4
604-576-2464
Wholesale and Retail
$2.00

5 Alpine Plants (1978)
P.O. Box 245
Tahoe Vista, CA 95732
916-546-5518
Wholesale and Retail
$1.00

9 Andre Viette Farm and Nursery (1930)
Route 1, Box 16
Fisherville, VA 22939
703-943-2315
Retail and Wholesale
$2.00

11 Appalachian Wildflower Nursery (1973)
Route 1, Box 275A
Reedsville, PA 17084
717-667-6998
Retail
$1.00—DFO

21 Bluemount Nurseries (1926)
2103 Blue Mount Road
Monkton, MD 21111
301-329-6226
Wholesale

23 Bluestone Perennials (1972)
7211 Middle Ridge Road
Madison, OH 44057
216-428-7535
Wholesale and Retail

25 Boehlke's Woodland Gardens (1981)
W. 140 North 10829
Country Aire Road
Germantown, WI 53022
414-251-8677
Retail
2 First Class Stamps, SASE

27 Burpee Ornamental Gardens
300 Park Ave.
Warminster, PA 18991
215-674-4915
Retail

29 Busse Gardens (1977)
Route 2, Box 238
Cokato, MN 55321
612-286-2654
Wholesale and Retail
$2.00, DFO

33 Camelot North (1981)
RR 2, Box 398
Piquot Lakes,
MN 56472
218-568-8922
Retail
$1.00, DFO

34 Canyon Creek Nurseries (1986)
3527 Dry Creek Road
Oroville, CA 95965
916-533-2166
Retail
$1.00

37 Carroll Gardens (1933)
P.O. Box 310
Westminster, MD 21157
800-638-6334
Wholesale and Retail
$2.00, DFO

39 Clifford's Perennial and Vine (1982)
Route 2, Box 320
East Roy, WI 53120
414-642-7156
Retail
$1.00, DFO

41 Coastal Gardens (1968)
4611 Socastee Blvd.
Myrtle Beach, SC 29575
803-293-2000
Wholesale and Retail
$1.50, DFO

43 Conley's Garden Center
145 Townsend Ave.
Boothbay Harbor, ME 04538
207-633-5020
Retail
$1.50

45 Copper's Garden (1978)
212 West Country Road, C
Roseville, MN 55113
612-484-7878
Retail
One First Class Stamp, SASE

49 Crownsville Nursery (1979)
P.O. Box 797
Crownsville, MD 21032
301-923-2212
Retail
$2.00, DFO

52 Donarama's Nursery (1977)
Upper Main Street, Box 2189
Edgartown, MA 02539
617-627-8366
Retail and Wholesale

54 Eco-Gardens (1977)
P.O. Box 1227
Decatur, GA 30031
404-294-6468
Retail
$1.00

61 Forestfarm (1974)
990 Tetherwest Road
Williams, OR 97544
503-846-6963
Wholesale and Retail
$2.00

63 Garden Perennials (1982)
Route 1
Wayne, NE 68787
402-375-3615
Retail
$1.00

65 Garden Place (1972)
Box 388
Mentor, OH 44061
216-255-3705
Retail
$1.00

66 Gardens of the Blue Ridge (1923)
P.O. Box 10
Pineola, NC 28662
704-733-2417
Retail
$2.00

67 Gilson Gardens (1947)
Box 277
Perry, OH 44081
Wholesale and Retail

69 Goodwin Creek Gardens (1979)
Box 83
Williams, OR 97544
Retail
$1.00, DFO

75 Hauser's Superior View Farm (1906)
Route 1, Box 199
Bayfield, WI 54814
715-779-5404
Wholesale and Retail

77 Holbrook Farm and Nursery (1980)
Route 2, Box 223B
Fletcher, NC 28732
704-891-7790
Retail
$2.00, DFO

83 Hortico, Inc. (1969)
Robson Road, RR 1
Waterdown, ON
L0R 2
416-689-6984
Wholesale and Retail
$1.00

87 Intermountain Cactus (1976)
2344 South Redwood Ave.
Salt Lake City, UT 84119
801-972-5149
Retail
Long SASE

91 Kurt Bluemel (1964)
2740 Greene Lane
Baldwin, MD 21013
301-557-7229
Wholesale and Retail
$2.00

95 Lamb Nurseries (1928)
E. 101 Sharp Ave.
Spokane, WA 99202
509-328-7956
Retail

97 Little Valley Wholesale Nursery (1980)
13022 E. 136th Ave.
Brighton, CO 80601
303-659-6708
Wholesale and Retail
$1.00

98 Logee's Greenhouses (1892)
55 North Street
Danielson, CT 06239
203-774-8038
Retail
$3.00, DFO

107 Milaeger's Gardens (1960)
4838 Douglas Ave.
Racine, WI 53402
414-639-2371
Retail
$1.00, DFO

109 Montrose Nursery (1984)
Box 957
Hillsborough, NC 27278
919-732-7787
Retail
$1.00

113 Native Gardens (1983)
Route 1, Box 494
Greenback, TN 37742
615-856-3350
Wholesale and Retail
$1.00, DFO

115 Natural Gardens (1984)
113 Jasper Lane
Oak Ridge, TN 37830
615-482-6746
Retail
$1.00, DFO

117 Niche Gardens (1985)
Route 1, Box 290
Chapel Hill, NC 27514
919-967-0078
Wholesale and Retail
$3.00

120 Orchid Gardens (1944)
2232 139th Ave, NW
Andover, MN 55304
Retail
Two First Class Stamps, SASE

123 Passiflora (1982)
Route 1, Box 190-A
Germantown, NC 27019
919-591-5816
Retail
$1.00

127 Prairie Nursery (1972)
P.O. Box 365
Westfield, WI 53964
608-296-3679
Wholesale and Retail
$1.00

133 Rice Creek Gardens (1972)
1315 66th Ave., NE
Minneapolis, MN 55432
612-574-1197
Wholesale and Retail
$1.00

137 Rocknoll Nursery (1928)
9210 U.S. 50
Hillsboro, OH 45133
513-393-1278
Wholesale and Retail
Two First Class Stamps, SASE

139 Russell Graham (1980)
4030 Eagle Crest Road, NW
Salem, OR 97304
503-362-1135
Wholesale and Retail
$2.00, DFO

143 Shady Oaks Nursery (1983)
700 19th Avenue, NE
Waseca, MN 56093
507-835-5033
Retail
$1.00, DFO

144 Sharp Plants, Inc.
Route 2, Box 265C
Asheville, NC 28805
704-298-4751
Wholesale and Retail

145 Siskiyou Rare Plant Nursery (1964)
2825 Cummings Road
Medford, OR 97501
503-772-6846
Retail
$2.00, DFO

153 Springbrook Gardens, Inc. (1946)
P.O. Box 388
Mentor, OH 44061
216-255-3059
Wholesale

157 Sunlight Gardens (1982)
Route 1, Box 600-A
Andersonville, TN 37705
615-494-8237
Wholesale and Retail
$2.00, DFO

159 Sunny Border Nurseries, Inc. (1945)
1709 Kensington Road
Kensington, CT 06037
203-828-0321
Wholesale

161 Surry Gardens (1978)
Box 145
Surry, ME 04684
207-667-4493
Wholesale and Retail
$2.00 (retail catalog)

165 Tideland Gardens (1978)
P.O. Box 549
Chestertown, MD 21620
301-778-5787
Wholesale

167 T & Z Nursery (1980)
28 West 521
Roosevelt Road
Winfield, IL 60190
312-293-1040
Wholesale

169 Walters Gardens
(1946)
P.O. Box 137
Zeeland, MI 49464
616-772-4697
Wholesale

171 Wayside Gardens
(1975)
Garden Lane
Hodges, SC 29653
800-845-1124
Retail
$1.00, DFO

173 We-Du Nurseries
(1981)
Route 5, Box 724
Marion, NC 28752
704-738-8300
Retail
$1.00, DFO

175 Whayes End
Nursery (1985)
P.O. Box 310
Burgess, VA 22432
804-453-3807
Wholesale and Retail
$2.00, DFO

177 White Flower
Farm (1949)
Route 63
Litchfield, CT 06759
203-567-0801
Retail
$5.00, DFO

181 Woodlanders, Inc.
(1980)
1128 Collecton Ave.
Aiken, SC 29801
803-648-7522
Retail
Two First Class
Stamps, SASE

183 Wrenwood of
Berkeley Springs
(1981)
P.O. Box 361
Berkeley Springs,
WV 25411
304-258-3071
Wholesale and Retail
$1.50, DFO

The nurseries listed below were not cross referenced in this source manual. Each carries numerous varieties or types of one particular plant or groups of plants. Please contact the nurseries directly for more information.

Aquatic Plants

Lilies of the Valley Water Gardens
26585 Rancho San Carlos
P.O. Box 22322
Carmel, CA 93922
$1.00, DFO

Lilypons Water Gardens
6800 Lilypons Road
P.O. Box 10
Lilypons, MD
21717-0010
301-874-5133
$4.00

Moore Water Gardens
Highway 4
P.O. Box 340
Port Stanley, ON NOL 2AO
519-782-4052

Paradise Gardens
14 May Street
Whitman, MA 02382
716-447-4711
$2.00

Santa Barbara Water Gardens
160 East Mountain Drive
Santa Barbara, CA 93103
805-682-8812
$1.00

Slocum Water Gardens
1101 Cypress Gardens Blvd.
Winter Haven,
FL 33880-6099
813-293-7151
$2.00

Van Ness Water Gardens
2460 North Euclid
Upland, CA 91786
714-982-2425
$3.00

Water Lily World
2331 Goodloe
Houston, TX 77093
713-694-8801
$3.00, DFO

William Tricker, Inc.
7125 Tanglewood Drive
Independence, OH 44131
$1.00

Bulbs

Alexander Heimlich
71 Burlington Street
Woburn, MA 01801

Amaryllis, Inc.
1452 Glenmore Ave.
P.O. Box 318
Baton Rouge, LA 70821
504-924-4521
$2.00, DFO

Anthony J. Skittone
2271 31st Ave.
San Francisco, CA 94116
415-681-3152

Bakker of Holland
Louisiana, MO 63353-0050
314-754-4525

Bio-Quest International
P.O. Box 5752
Santa Barbara,
CA 93150-5752
805-969-4072
$1.00

Breck's
6523 North Galena Road
Peoria, IL 61601
309-691-4601

C.A. Cruikshank, Ltd.
1015 Mount Pleasant Road
Toronto, ON M4P 2M1

DeJager Bulbs
188 Asbury Street
South Hamilton, MA 01982
617-468-1622

Dutch Gardens, Inc.
P.O. Box 588
Farmingdale, NJ 07727

Edgar L. Klein
17495 SW Bryant Road
Lake Grove, OR 97034

Flower Bulbs, Inc.
P.O. Box 344
941 New Durham Road
Edison, NJ 08817

French Bulb Importers
Route 100
Pittsfield, VT 05762

Gladside Gardens
61 Main Street
Northfield, MA 01360
413-498-2657
$1.00, DFO

HHH Horticultural
68 Brooktree Road
Hightstown, NJ 08520

John D. Lyon, Inc.
143 Alewife Brook Parkway
Cambridge, MA 02140
617-876-3705

John Scheepers, Inc.
63 Wall Street
New York, NY 10005
212-422-1177

Marcia's
131 Oak Knoll
San Antonio, TX 78228
$1.50

Mary Mattison van Schaik
Route 1, Box 181
Cavendish, VT 05142
802-226-7338
Two First Class Stamps

McClure and Zimmerman
1422 W. Thorndale
Chicago, IL 60660
312-989-0557

Messelaar Bulb Co.
150 Country Road
Ipswich, MA 01938
617-356-3737

Michigan Bulb Co.
1950 Waldorf NW
Grand Rapids, MI 49550
616-453-5401

Oregon Bulb Farms
39391 S.E. Tusted Road
Sandy, OR 97055
503-663-3133
$2.00, DFO

Quality Dutch Bulbs
50 Lake Drive
P.O. Box 225
Hillsdale, NJ 07642
201-391-6586

Rex Bulb Farms
2568 Washington Street
P.O. Box 774
Port Townsend, WA 98368
206-385-4280
$1.00

Royal Gardens
282 Fairfield Road
P.O. Box 588
Farmingdale, NJ 07727
201-780-2713

Shields Horticultural
Gardens
P.O. Box 92
Westfield, IN 46074

TyTy Plantation
P.O. Box 159
TyTy, GA 31795
912-386-8400

Van Bourgondien Bros.
245 Farmingdale Road
Route 109
P.O. Box A
Babylon, NY 11702
516-669-3500

Van Engelen, Inc.
307 Maple Street
Litchfiled, CT 06759
203-567-9222

Vandenberg
Black Meadow
Road Chester, NY 10918
914-469-9163

West Shore Acres
956 Downey Road
Mount Vernon, WA 98273

Willetts
P.O. Box 446
Moss Landing, CA 95039

Daffodils

The Daffodil Mart
Route 3, Box 794
Gloucester, VA 23601
804-693-3966
$1.00

Grant Mitsch
Novelty Daffodils
P.O. Box 218
Hubbard, OR 97032
503-651-2742
$3.00, DFO

Hatfield Gardens
22799 Ringgold
Southern Road
Stoutsville, OH 43154
614-474-5719
$1.00

Nancy Wilson Species and
Miniature Narcissus
571 Woodmont Ave.
Berkeley, CA 94708
415-524-5714

Oakwood Daffodils
1390 Niles-Buchanan Road
Buchanan, MI 49107
616-695-6848

River's Edge Farm
Route 4, Box 228A
Gloucester, VA 23061
804-693-4374

Dahlias

Alger Gardens
2044 Great Falls Street
Falls Church, VA 22043

Almand's Dahlia Gardens
2541 West Ave. 133
San Leandro, CA 94577
Two First Class Stamps,
SASE

Alpen Garden
173 Lawrence Lane
Kalispell, MT 59901
406-257-2540

Bateman's Dahlias
6911 SE Drew Street
Portland, OR 97222
503-774-4817

Blue Dahlia Gardens
Box 316
San Jose, IL 62682
309-247-3210

Campobello Dahlia Gardens
Route 1, Box 243
Campobello, SC 29322

Carson Dahlia Farm
245 Blauser Road
Castle Rock, WA 98611

Connell's Dahlias
10216 40th Ave. East
Tacoma, WA 98446
206-531-0292
Two First Class Stamps

Dahlias by Phil Traff
1316 32nd Avenue East
Sumner, WA 98390

Douglas Dahlias
Route 1, Box 91
Myrtle Creek, OR 97457

Ferncliff Gardens
SS 1
Mission, BC V2V 5V6

Garden Valley Dahlias
406 Lower Garden
Valley Road
Roseburg, OR 97470
503-673-8521

Golden Rule Dahlia Farm
3460 North State Route 48
Lebanon, OH 45036
513-932-3805

Hooklands Dahlias
1096 Horn Lane
Eugene, OR 97404
503-688-7792

Kordonowy's Dahlias
P.O. Box 1049
Castle Rock, WA 98611
206-274-6247

Lamson and Sons Dahlias
Route 4, Box 4279B
Selah, WA 98942

Land-A-Goshen Gardens
P.O. Box 178
Nooksack, WA 98376

Legg Dahlia Gardens
1069 Hastings Road
RD 4, Box 168
Geneva, NY 14456
315-789-1209

Paul Hale
106 Baker Street
Brighton, IL 62012
618-372-8685

Ruschmohr Dahlias
P.O. Box 236
Rockville Centre, NY 11571
516-766-1761

Sea-Tac Gardens
20020 Des Moines
Way South
Seattle, WA 98148
206-824-3846
SASE

Shackleton's Dahlias
30535 Division Drive
Troutdale, OR 97060
503-663-5718
SASE

Swan Island Dahlias
995 NW 22nd
P.O. Box 800
Canby, OR 97013
503-266-7711
$2.00, DFO

Daylilies

Alpine Valley Gardens
2627 Calistoga Road
Santa Rosa, CA 95404-9618
707-539-1749
SASE

Barnee's Garden
Route 10, Box 2010
Nacogdoches, TX 75961

Big Tree Daylily Farm
Box 148
Longwood, FL 32750

Borbelata Gardens
15974 Canby Ave.
Route 5
Faribault, MN 55021
$3.00

Burkey Gardens
Loretto,
PA 15940
SASE

Caprice Farm Nursery
15125 SW Pleasant
Hill Road
Sherwood, OR 97140
503-625-7241
$1.00

Cordon Bleu Farms
P.O. Box 2033
San Marcos, CA 92069
$1.00

Daylily World
P.O. Box 1612
Sanford, FL 32771
305-322-4034

Englerth Gardens
2461 22nd Street
Hopkins, MI 49238
616-793-7196

Gilbert H. Wild and Son
1112 Joplin Street
Sarcoxie, MO 64862-0338
417-548-3514
$2.00-DFO

Greenwood Nursery
2 El Camino Real
Goleta, CA 93117
$1.00, DFO

Hatfield Gardens
previously listed under
Daffodils

Holiday Seeds
1276 Durham Circle
Stone Mountain, GA 30083
$1.00

Houston Dayhly Gardens
P.O. Box 7008
The Woodlands, TX 77380
713-350-5577
$2.00, DFO

Hughes Garden
2450 N. Main Street
Mansfield, TX 76063
SASE

Iron Gate Gardens
Route 3, Box 250
Kings Mountain, NC 28086
704-435-6178

Jernigan Gardens
Route 6, Box 593
Dunn, NC 28334
919-567-2135
Long SASE

Joiner Gardens
33 Romney Place
Savannah, GA 31406
Long SASE

Klehm Nursery
197 Penny Road
South Barrington, IL 60010
312-437-2880
$2.00, DFO

Lee Bristol Nursery
RR 1, Box 148
Gaylordsville, CT 06755
203-354-6951
Long SASE

Lenington-Long Gardens
7007 Manchester Ave.
Kansas City, MO 64133
816-454-9163
Two First Class Stamps

Maple Tree Gardens
208 First Street
P.O. Box 278
Ponca, NE 68770
402-755-2615

Meadowlake Gardens
Route 4, Box 709
Waterboro, SC 29488
$2.00, DFO

Oakes Daylilies
Route 3
Corryton, TN 37721
615-689-3036

Pilley's Gardens
2829 Favill Lane
Grants Pass, OR 97526

Powell's Gardens
Route 3, Box 21
Princeton, NC 27659
919-936-4421
$2.00, DFO

Saxton Gardens
1 First Street
Saratoga Springs, NY 12866
Two First Class Stamps,
SASE

Seawright Gardens
134 Indian Hill
Carlisle, MA 01741
617-369-2172
$1.00, DFO

Solomon Daylilies and Iris
105 Country Club Road
Newport News, VA 23606
804-595-3850

Soules Garden
5809 Rahke Road
Indianapolis, IN 46217
317-786-7839

Thomasville Nurseries
1842 Smith Ave.
P.O. Box 7
Thomasville,
GA 31799-0007
912-226-5568

Thundering Springs Garden
P.O. Box 2013
Dublin, GA 31021
912-272-1526

Tranquil Lake Nursery
45 River Street
Rehoboth, MA 02769
617-252-4310
SASE

Ferns

Fancy Fronds
1911 4th Ave.
West Seattle, WA 98119
206-284-5332
$1.00

Foliage Gardens
2003 128th Ave. SE
Bellevue, WA 98005
206-747-2998
$1.00

McGregor Nursery
Hanover, PA 17333

Nature's Garden Nursery
Route 1, Box 488
Beaverton, OR 97007
503-649-6772
$1.00, DFO

Piedmont Gardens
533-577 Piedmont Street
Waterbury, CT 06706
203-754-8534
Two First Class Stamps, SASE

Strand Nursery Co.
Box 187, Route 3
Osceola, WI 54020

Varga's Nursery
2631 Pickertown Road
Warrington, PA 18976
215-343-0646

Yerba Buena Nursery
19500 Skyline Blvd.
Woodside, CA 94062
415-851-1668
$1.00

Herbs

ABC Herb Nursery
P.O. Box 313
Lecoma, MO 65540
314-435-6389
SASE

Bear Meadow Farm
Route 2, Moore Road
Florida, MA 01247
413-663-9241
$1.00, DFO

Bittersweet Farm
6294 Seville Road
Seville, OH 44272
216-887-5293

Caprilands Herb Farm
534 Silver Street
Coventry, CT 06238

Catnip Acres Farm
67 Christian Street
Oxford, CT 06483
203-888-5649
$1.00

Companion Plants
Route 6, Box 88
Athens, OH 45701
614-592-4643
$1.50, DFO

Dionysos' Barn
P.O. Box 31
Bodines, PA 17722
717-995-5453

Earthstar Herb Gardens
438 W. Perkinsville Road
Star Route 1, Box 82
Chino Valley, AZ 86323
602-636-2565
$1.00, DFO

Earthworks Herb Garden Nursery
923 North Ivy Street
Arlington, VA 22201
703-243-2498
$1.00

Fox Hill Farms
440 West Michigan Ave.
P.O. Box 7
Parma, MI 49269
517-531-3179
$1.00

Fragrant Fields
Route 2, Box 199
Dongola, IL 62926
618-827-3677
$1.00

Hartman's Herb Farm
Old Dana Road
Barre, MA 01005
617-355-2015
$1.00

Hemlock Hill Herb Farm
Hemlock Hill Road
Litchfiled. CT 06759-0415
203-567-5031
Two First Class Stamps, SASE

Herbs 'N Honey Nursery
16085 Airlie Road
P.O. Box 124
Monmouth, OR 97361

Jude Herbs
P.O. Box 563
Huntington Station, NY 11746
$1.00, DFO

Lost Prairie Herb Farm
Star Route
Marion, MT 59925-9998
$2.00, DFO

Merry Gardens
Upper Mechanic Street
PO Box 595
Camden, ME 04843
207-236-9064
$1.00

Rasland Farm
NC 82 at US 13
Godwin, NC 28344
919-567-2705
$1.00

Rutland of Kentucky
Jail Street
PO Box 182
Washington,
KY 41096-0182
606-759-7815
$2.00

Sandy Mush Herb Nursery
Route 2, Surrett Cove Road
Leicester, NC 28748
704-683-2014
$2.00, DFO

Sunnybrook Farms Nursery
9448 Mayfield Road
PO Box 6
Chesterland, OH 44026
216-729-7232
$1.00

Sunnypoint Gardens
6939 Highway 42
Egg Harbor, WI 54209
414-868-3646

Tansy Farm
5888 Else Road, RR 1
Agassiz, BC V0M 1A0
604-796-9316
$1.50

Taylor's Herb Garden
1535 Lone Oak Road
Vista, CA 92083
619-727-3485
$1.00

Triple Oaks Nursery
Route 47
Franklinville, NJ 08322
609-694-4272

Well-Sweep Herb Farms
317 Mount Bethel Road
Port Murray, NJ 07865
201-852-5390
$1.00

Wyrttun Ward
18 Beach Street
West Wareham, MA 02576
617-866-4087
$1.00

Hosta

Caprice Farm Nursery
listed previously under
Daylilies

Donnelly's Nursery
Route 7, Box 420
Fairview, NC 48730

Englerth Gardens
listed previously under
Daylilies

Fairway Enterprises
114 The Fairway
Albert Lea, MN 56007
$1.00

Hatfield Gardens
listed previously
under Daffodils

Hildenbrandt's Iris Gardens
HCR 84, Box 4
Lexington, NE 68850

Homestead Division of
Sunnybrook Farms
9448 Mayfield Road
Chesterland, OH 44026
216-729-9838
$1.00

Holiday Seeds
listed previously
under Daylilies

Iron Gate Gardens
listed previously
under Daylilies

Jernigan Gardens
previously listed
under Daylilies

Klehm Nursery
listed previously
under Daylilies

Maroushek Gardens
120 East 11 Street
Hastings, MN 55033
612-437-9754
Two First Class Stamps,
SASE

Piedmont Gardens
533-577 Piedmont Street
Waterbury, CT 06706
203-754-8534
Two First Class Stamps,
SASE

Powell's Gardens
listed previously
under Daylilies

Savory's Greenhouse
5300 Whiting Ave.
Edina, MN 55435
612-941-8755
$1.00, DFO

Saxton Gardens
listed previously
under Daylilies

Soules Garden
listed previously
under Daylilies

Iris

Adamgrove
Route 1, Box 246
California, MO 65018
314-796-3829

Aitkens Salmon
Creek Garden
608 NW 119th Street
Vancouver, WA 98685
206-573-4472
SASE

Anderson Iris Gardens
22179 Keather Ave. North
Forest Lake, MN 55025

Avonbank Iris Garden
Redford University
P.O. Box 5961
Redford, VA 24142
703-639-1333

Baldwin's Iris Gardens
P.O. Box 615
College Place, WA 99324

Barnee's Garden
previously listed
under Daylilies

Bay View Gardens
1201 Bay Street
Santa Cruz, CA 95060
408-423-3656
$1.00

Borbelata Gardens
previously listed
under Daylilies

Cal Dixie Iris Gardens
14115 Pear Street
Riverside, CA 92504

Cape Iris Gardens
822 Rodney Vista Blvd.
Cape Girardeau, MO 63701

Caprice Farm Nursery
previously listed
under Daylilies

Charjoy Gardens
117 Acacia Drive
Lafayette, LA 70508

Chehalem Gardens
Chehalem Drive
P.O. Box 693
Newberg, OR 97132
503-538-8920

Cherry Lane Gardens
2988 Cherry Lane
Walnut Creek, CA 94596
415-932-1998
Two First Class Stamps

Circle N. Ranch
18650 Birch Street
Perris, CA 92370
714-780-7325
Two First Class Stamps

Comanche Acres
Iris Gardens
Route 1, Box 258
Gower, MO 64454
816-424-6436
$1.00

Contemporary Gardens
P.O. Box 534
Blanchard, OK 73010
SASE

Cooley's Gardens
P.O. Box 126
Silverton, OR 97381
$2.00

Cordon Bleu Farms
previously listed
under Daylilies

Cottage Gardens
11294 Randolph Road
Wilton, CA 95693
916-687-7902
SASE

Cottonwood Garden
Moville, IA 51039
SASE

C. Criscola Iris Garden
Route 2, Box 183
Walla Walla, WA 99362

David B. Sindt Irises
1331 W. Cornelia
Chicago, IL 60657-1401
312-528-3064

Deming Iris Gardens
4122 Deming Road
Everson, WA 98247
Two First Class Stamps

Englerth Gardens
previously listed
under Daylilies

Ferncliff Gardens
previously listed
under Dahlias

Garden of the
Enchanted Rainbow
Route 4, Box 439B
Killeen, AL 35645
SASE

Gilbert H. Wild and Son
previously listed
under Daylilies

Grandview Iris Gardens
HC 86-Box 91
Bayard, NE 69334
308-586-1471
SASE

Hahn's Rainbow Iris Garden
200 North School Street
Desloge, MO 63601
314-431-3342

Hamner's Iris Garden
960 North Perris Blvd
Perris, CA 92370

Hildenbrandt's Iris Gardens
previously listed
under Hosta

Holiday Seeds
previously listed
under Daylilies

Illini Iris
Route 3, Box 5
Monticello, IL 61856
217-762-3446
$1.00, DFO

Imperial Flower Garden
Box 255
Cornell, IL 61319

Iris Acres
P.O. Box 189
Williamac, IN 46996
219-946-4197
Two First Class Stamps

Iris Country
118 South Lincoln Street
Wayne, NE 68787
402-375-3795
Two First Class Stamps

Iris Ranch
P.O. Box 227
Cerrillos, NM 87010
$1.00

Iris Test Gardens
1010 Highland Park Drive
College Place, WA 99324
509-525-8804

J-Lot Gardens
Route 3, Box 496
Joshua, TX 76058
817-295-4074
Two First Class Stamps

Keith Keppel
P.O. Box 8173
Stockton, CA 95208
209-463-0227
Two First Class Stamps

Kirkland Iris Garden
725-20 Avenue West
Kirkland, WA 98033
206-828-4907

Laurie's Garden
41886 McKenzie Highway
Springfield, OR 97478
SASE

Long's Gardens
3240 Broadway
Box 19
Boulder CO 80306
303-442-2353

Maple Tree Gardens
previously listed
under Daylilies

Maryott's Gardens
1678 Andover Lane
San Jose, CA 95124
408-265-2498
$1.00, DFO

Maxim's Greenwood
Gardens
2157 Sonoma Street
Redding, CA 96001
916-241-0764

Melrose Gardens
309 Best Road South
Stockton, CA 95206
$1.00

Mid-America Gardens
3409 North Geraldine
P.O. Box 12982
Wheatland, OK 73157
405-524-3046

Miller's Manor Gardens
3167 E. US 224
Ossian, IN 46777
219-597-7403

Mission Bell Gardens
2778 West 5600 South
Roy, VT 84067

Moonshine Gardens
P.O. Box 1019
Clearlake Oaks, CA 95423
707-998-3055

Mrs. Milton Ogburn
Route 1, Box 31
Smithfield, NC 27577
919-934-6566

North Pine Iris Gardens
P.O. Box 595
Norfolk, NE 68701
402-371-3895
$1.00, DFO

Pacific Coast Hybridizers
P.O. Box 972
Campbell, CA 95009-0972
408-370-2955
$1.00, DFO

Pleasure Iris Gardens
425 East Luna
Chaparral, NM 88021
505-824-4299
$1.00, DFO

Powell's Gardens
previously listed
under Daylilies

Randy's Iris Garden
186 W. 800 North
Sunset, UT 84015

Redbud Lane Iris Garden
RR 1, Box 141
Kansas, IL 61933
217-948-5478
Two First Class Stamps

Rialto Gardens
1146 W. Rialto
Fresno, CA 93705

Riverdale Iris Gardens
7124 Riverdale Road
Minneapolis, MN 55430
612-561-1748
$1.00, DFO

Schreiner's Gardens
3625 Quinaby Road, NE
Salem, OR 97303
503-393-3232
$2.00

Shanon Gardens of
Oak Brook Farm
30545 Tern Avenue
Shafer, MN 55074
612-644-0598

Shepard Iris Garden
3342 West Orangewood
Avenue
Phoenix, AZ 85051
602-841-1231
$1.00

Skyline Farms
Route 1, Box 162
Whitewright, TX 75491
SASE

Solomon Daylilies and Iris
previously listed
under Daylilies

The Iris Pond
7311 Churchill Road
McLean, VA 22101
$1.00

Tranquil Lake Nursery
previously listed
under Daylilies

21st Century Gardens
3237 Eisenhower Street
Eau Claire, WI 54701
715-839-7053
$1.00, DFO

Wright Iris Nursery
6583 Pacheco Pass Highway
Gilroy, CA 95020
408-848-3124

Lilies

B and B Laboratories
1600 D. Dunbar Road
Mt. Vernon, WA 98273
206-424-5647 SASE

B and D Lilies
330 P. Street
Port Townsend, WA 98368
206-385-1738
$1.00, DFO

Bluebells Lilies, Inc.
1432 Manor Lane Blue Bell,
PA 19422-2022

Borbelata Gardens
previously listed
under Daylilies

Fairyland Begonia
and Lily Garden
1100 Griffith Road
McKinleyville, CA 95521
707-839-3034
Two First Class Stamps

Gaybird Nurseries
P.O. Box 42
Wawanesa, Manitoba
Canada R0K 2G0

Honeywood Lilies
P.O. Box 63
Parkside, SK S0J 2A0
306-747-3296
$1.00

Kent Lilies
2009 Edgewood NE
Grand Rapids, MI 49505

Riverside Gardens
RR 5
Saskatoon, SK S7K 3J8
306-374-0494

Strahms Lilies
15723 Ocean View Drive
P.O. Box 2216
Harbor, OR 97415-0307
503-469-3792
Two First Class Stamps

Trinidad Bay Bulb Co.
P.O. Box 974
Trinidad, CA 95570

Chrysanthemums

Dooley Gardens
Route 1
Hutchinson, MN 55350

Fleming Flower Fields
3100 Leighton Ave.
P.O. Box 4617
Lincoln, NE 68504

Hutts Garden Mums
618 Jumiata
P.O. Box 187
Burlington, KS 66839-0187
316-364-2933

King's Mums
20303 East Liberty Road
P.O. Box 368
Clements, CA 95227-0368
209-759-3571
$1.00

Mums by Paschke
11286 Main Road
North East, PA 16428

New England Mum Co.
State Route 16
P.O. Box 51
Sorrento, FL 32776
904-383-2133

Reno Nurseries
2718 Washington Street
Dubuque, IA 52001

Sunnyslope Gardens
8638 Huntington Drive
San Gabriel, CA 91775
818-287-4071

The Lehman Gardens
120 SW Tenth Street
Faribault, MN 55021

Thon's Garden Mums
1811 Oak Street
Crystal Lake, IL
60014 815-459-1030

Peonies

Atha Gardens
West Liberty, OH 43357

Brand Peony Farm
P.O. Box 842
St. Cloud, MN 56302
$1.00

Caprice Farm Nursery
listed previously
under Daylilies

Ferncliff Gardens
listed previously
under Dahlias

Gilbert H. Wild and Son
listed previously
under Daylilies

Gratwick Tree Peonies
1912 York Road
Pavilion, NY 14525

Hildenbrandt's Iris Gardens
listed previously
under Hosta

Klehm Nursery
listed previously
under Daylilies

Lienau Peonies
9135 Beech Daly Road
Detroit, MI 48239

Myron D. Bigger
201 North Rice Road
Topeka, KS 66616

Reath's Nursery
100 Central Blvd.
P.O. Box 521
Vulcan, MI 49892
$1.00

Smirnow's Sons
11 Oakwood Drive, Route 1
Huntington, NY 11743
$2.00

The New Peony Farm
P.O. Box 18105
St. Paul, MN 55118
612-457-8994

Primulas

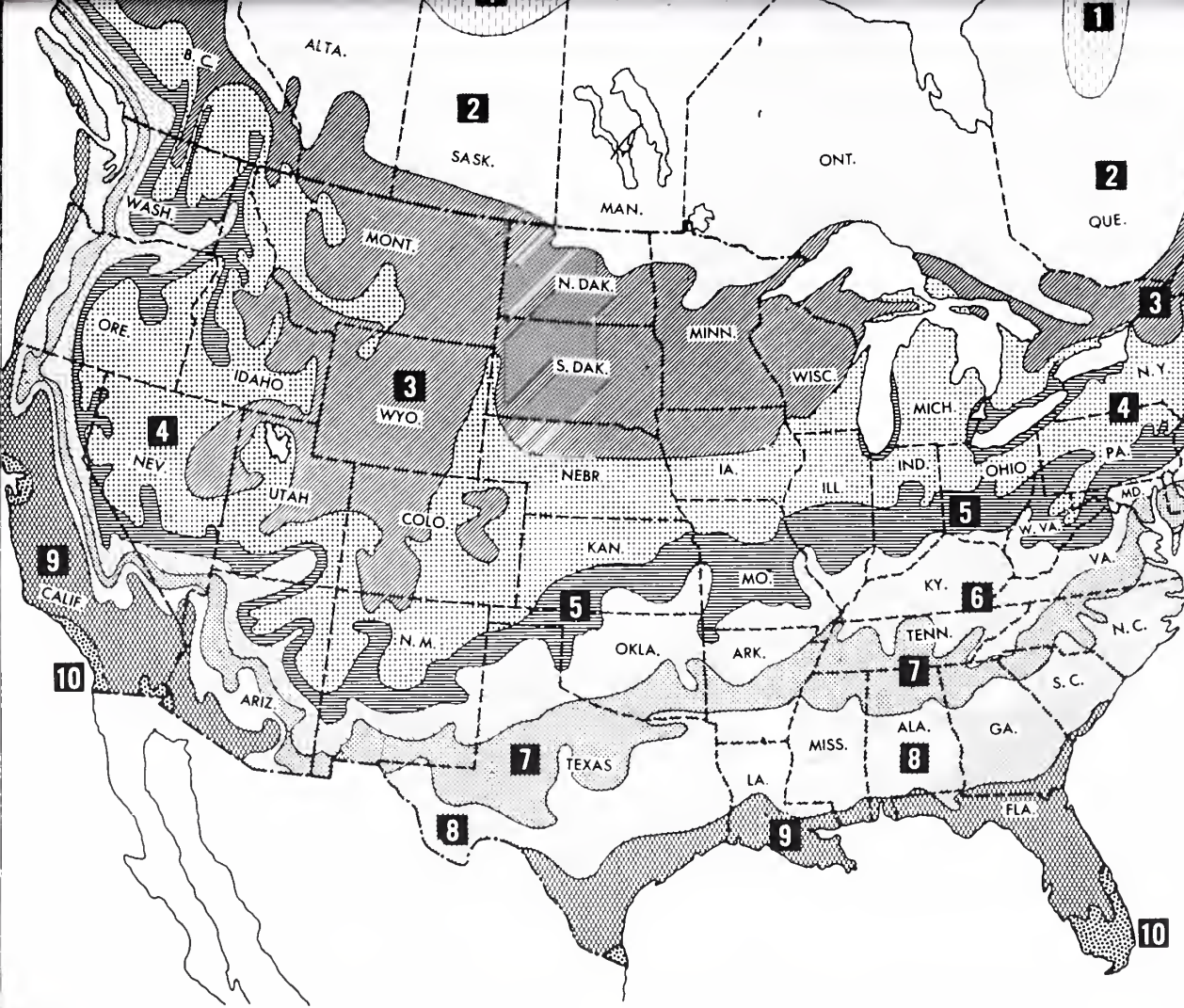
Bailey's
P.O. Box 654
Edmonds, WA 98020

Grand Ridge Nursery
27801 SE High Point Way
Issaquah, WA 98027

Tulips

Veldheer Tulip Gardens
12755 Quincy Street
Holland, MI 49423
616-399-1900

Victory Garden South located at Callaway Gardens contains zinnias, marigolds, boxwood and crape myrtle in the background. Mixed borders add color and interest to the garden.



HARDINESS ZONE MAP

The Limits of the Average Annual Minimum Temperatures for Each Zone

Zone 1.	Below	—50°	F.
Zone 2.	—50°	to —35°	
Zone 3.	—35°	to —20°	
Zone 4.	—20°	to —10°	
Zone 5.	—10°	to —5°	
Zone 6.	—5°	to 5°	
Zone 7.	5°	to 10°	
Zone 8.	10°	to 20°	
Zone 9.	20°	to 30°	
Zone 10.	30°	to 40°	

Compiled by The Arnold Arboretum, Harvard University

Bibliography

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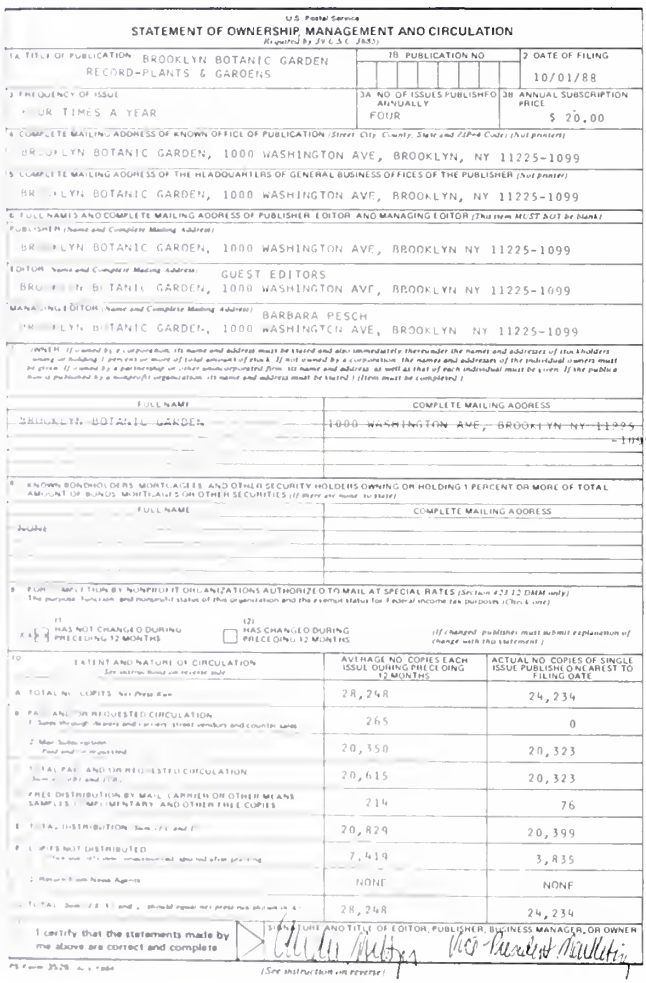

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